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THE RELATIONS BETWEEN THE VARIABILITY OF ORGANISMS AND THAT OF THEIR CONSTITUENT ELEMENTS.

IN a study of the varying forms of organisms we may either direct our attention to the variability of the organism as a whole, or to the variability of its constituent elements. When two organisms differ in form, their differences are necessarily founded on differences in the forms of their corresponding parts, and we are justified in assuming each of these parts as very small. The corresponding parts may consist of homologous cell groups, of individual cells, or of other small homologous elements of the two organisms. These small elements may differ in size and form, and new elements may also be added in the one or the other organism, so that there may also be a difference in the number of elements. The difference between the two organisms may then be considered as a resultant of the differences between their constituent elements. Therefore, there must be a certain definite relation between the variability of the elements and that of the whole organism.

In order to make this clear we will, for a moment, consider the elements as independent units, not as parts of an organic whole. In this case, each element would be entirely independent of the other. When we consider two organisms thus con-

stituted in which the total number of cells is the same, we find that they cannot possess any variability, because the variations of the constituent cells would compensate each other. This can be proven as follows: If we determine the form of an organism by a number of measurements taken in various directions, then each measurement may be considered as made up of many constituent elements. On the average, the variability of the combined elements will be proportionate to the square root of the number of elements, while the value of the total length of the combined elements will be proportionate to their number. If, therefore, the number of elements is very great—and there is nothing to hinder us in assuming each element as very small and their number as very great—the variability of the whole measurement must be very small, according to the small value of the proportion between the square root of the number of elements, and the number of elements. Since this contradicts the fact that all organisms are variable, it follows that the elements cannot be constant in number and mutually independent. This conclusion is obvious from a morphological point of view, but it seemed desirable to point out that the independence and constant number of elements would entail lack of variability in the whole organism.

If the elements were independent of each other but varied in number, we might assume in accordance with morphological observation that each group of elements had a certain limited period of multiplication which proceeds at a definite average rate. Then it may be said that this period undergoes certain changes that are due to chance. If this were the case, the size of the organ would increase approximately in geometrical progression when the period increases in arithmetical progression.

It is probable that, on the whole, the periods of development of various organisms vary around the typical period according to the laws of chance. Then the frequencies of periods belonging to different individuals would be arranged symmetrically around the typical period, while the measurements corresponding to each period and belonging to different individuals would be arranged asymmetrically around the type, in accordance with the relations between size and period. It is quite evident that the observed distributions of variations around a type do not generally conform with a law of this character, and therefore this theory must also be rejected as insufficient, although we recognize that it may explain a part of the general phenomena of variability.

It is, therefore, necessary to assume the elements of organisms to be correlated. This is entirely in accord with the evidence of morphology and of pathology. If the number of elements is assumed as constant, it is easy to determine what the results of such correlation must be. 'Correlation' means that the change in form and size of one element influences more or less the forms and sizes of other elements. Such correlated elements may either be contiguous, or they may be related in some other way. The degree of their relation may be expressed by an index of correlation.

If the correlation of all the elements were perfect, that is to say, if a change in one would necessitate a corresponding change of a certain definite amount in all the others, the variability of the whole organism would be proportioned to the average variability and number of the homologous elements. This condition is as unlikely as that of complete independence of the elements. We must draw the conclusion that the variability of the organism as a whole will always be less, in proportion to its size, than the variability of its constituent elements; or, as we might perhaps say, the

variability of the individual cells that constitute an organism must always be greater than the variability of the whole organism.

It may be well to illustrate the effects of correlation by assuming simplified conditions of correlation.

Assuming first, that the elements may be classed in a limited number of groups, each consisting of interdependent elements, so that the enlargement of one element of each group would necessitate a definite amount of enlargement of all the others. Furthermore be it assumed that the chances of a small number of these groups being enlarged are subject to accidental causes. Then the probability that one, two, three, or more of these groups are affected can be calculated according to the binomial law. Each group would contribute a definite, invariable amount to the total variability and the general variability would, therefore, also conform to the binomial law.

We will next assume a case which is somewhat nearer natural conditions. When we count and measure the total number of elements in *all* the individuals of a variable series, we obtain certain definite numbers of elements of various sizes and we can express numerically the frequency or probability of each size. In order to simplify matters, we will speak only of elements of decreased size and of enlarged size. The proportion of these two classes is definite in the total number of elements belonging to the different organisms of the series. If inside of each organism there were no correlation, then the proportion of large and small elements in each organism would, on account of the great number of elements, correspond to their proportions in the whole mass of elements. On account of the existence of correlations in each organism the occurrence of each enlarged element will have the effect, that an additional number of enlarged elements may be expected in the same organism, and the occurrence of an element of decreased size will add to the probability of elements of this character in the organism in which it occurs. The arrangement of these elements becomes, therefore, similar to that in a mechanical mixture of elements of two sizes, which are not uniformly distributed, but in which large and small parts cluster together. It is quite clear that the variability of distribution in such a mixture must be quite different from that found in cases of even mixture. It will depend entirely upon the distribution of large and small elements, and the number of elements of both classes that are found in a unit of space, how their proportion in each unit of space will vary.

We may obtain an insight into such variabilities by a consideration of the results obtained by taking a certain number of contiguous balls out of a row containing large and small balls that are not thoroughly mixed. The two arrangements given under 1 and 2 may serve as examples:

1. ● ● ● ● • • • ● ● ●
2. ● ● ● • ● • • ● ● ●

If four contiguous balls are taken out of each of these rows, we find that in the drawings made from the two series large balls occur as follows:

	Series 1.	Series 2.
4 large balls	1 Time	0 Times
3 " "	2 Times	3 "
2 " "	2 "	3 "
1 " ball	2 "	1 Time

Evidently, the distribution in cases of this kind cannot be foretold. This result may be expressed in a more general form as follows: If only one series of elements of an organism are interdependent, and all the others independent, the variability of form of all the individuals will depend primarily upon the distribution of disturbances in the interdependent elements in the whole series of individuals. Therefore the distribution of variations cannot be fore-

told. The same is true if the number of groups of interdependent elements is small.

When, however, the number of these groups of interdependent elements is somewhat greater and each group of correlations is independent of the other, then the conditions approach again those described before, when we assumed a number of groups in which the size of one element of a group determines the sizes of all the other elements of the same group. We may then expect to find a distribution the type of which is determined by the binomial law, because the combinations of groups that occur in each individual are determined by this law, while the law must be modified by the variability of the size of each correlated group, taken as a total. It is quite evident that the resultant curve must be similar in its general character to the series of binomial points, but continuous on account of the variability of each group. This phenomenon is still further complicated by the variation in the number of elements, the effect of which was discussed before.

We may reach the same result by assuming that the form of the whole organism is affected by a limited number of causes variable in intensity, each of which influences to a measurable degree the form of the organism. The combination of such groups of independent causes, limited in number and each having measurable results will bring about a distribution of variations of the same character as the one described before. The phenomenon, expressed in this manner, does not differ from the expression found before, because it does not seem probable that each cause would affect all the elements comprising the organism in the same manner. It seems much more likely that certain groups of elements will be affected more by one cause than by another. At the same time, it is possible that the same element may be subject to several causes and thus belong to various groups of correlated elements. Karl Pearson's discussions have shown that many distributions can be explained satisfactorily by assuming that they correspond to a continuous function determined by the points binomial.

It will be noted that, on the whole, the greater a variable measurement, the more nearly will the distribution of variations be symmetrical and in conformity with the exponential law. This may be expected, because the greater the measurement, the greater will probably be the number of independent, correlated groups. The increase of their number necessitates an approach to the exponential law. On the other hand, the smaller the measurement, the more probable that a great part of its constituent elements are subject to the same causes, so that the conditions are favorable to the combination of a small number of independent causes, each of which brings about considerable variation, so that we may expect as a resultant skew distributions of variations.

It would seem, therefore, that the whole range of phenomena of variability can be understood on the basis of our conception of the relations between the variability of the small constituent elements of an organism and the variability of the organism itself. We are justified in drawing the following conclusions:

1. The elements of organisms are more variable than the organisms themselves.

2. The elements of organisms vary in correlated groups.

3. The characteristics of the variability of an organism depend upon the correlations of its constituent elements, so that a knowledge of these correlations will enable us to determine the characteristics of the variability of the organism.

It follows from this that the problem of variability may be treated by a study of the variability and of the correlations of

the constituent elements of organisms. The study of physiological and pathological variations that elucidate correlations will, therefore, be a most powerful factor in the discussion of the problem of variability.

This point of view coincides closely with that of Rudolf Virchow who has always emphasized that the clue for the problems of variability must be looked for in the study of cellular variation.

Under certain simplified assumptions the problem, as here defined, may be made amenable to statistical treatment. If all the contributory causes of variation are given equal weight, and if it is assumed that the index of correlation for all the groups is the same, then it is only necessary to determine four unknown quantities: the total number of causes (or correlated groups); the probable number of causes (or correlated groups); the amount of influence of each cause (or correlated group) upon the whole organism; the variability of the effect of each cause (or correlated group) upon the whole organism. These few data can be calculated without any great difficulty from the averages of the first four powers of the individual variations. This method may be serviceable as long as the actual correlations are unknown.

Still another conclusion may be drawn from our considerations. We have seen that the variability of an organism depends upon the correlations of its elements, and that the variability must be the greater the closer these correlations and the less the number of correlated groups. At the same time, the variations will be the more likely to have skew distributions, the less the number of correlated groups. A disturbance in one element of an organism thus constituted must, therefore, result in a considerable variation of the whole. That is to say, that in the case of skew distributions of variations we may expect sudden transformations of type due to small causes. In organisms in which the variability is symmetrical, we may generally expect the whole form to be controlled by many independent causes, or by many independent groups of correlated elements. In this case, the changes of form due to small changes of conditions will probably be less marked.

The principal advantage of the method of considering variation that has been here suggested is that the occurrence of variations in fixed lines, that are so difficult to understand, may be considered as a result of chance variation of small elements and of physiological correlation. Both of these are much more readily understood than a variation of form that does not show any immediate relation to the causes producing the variation.

It has often been asserted, or assumed, that skew distribution of variations is a proof of the effect of selection, or of some other kind of instability of type. Our considerations have shown that this is not necessarily the case. Skew distributions may be found in stable forms. On the whole, it does not seem possible to discover by purely statistical methods the causes of skewness. The numerical material obtained by measurements can be made to fit satisfactorily many theories that would account for the skewness. It is necessary to base such theories on biological investigations and to subordinate our statistical methods to the biological point of view. Otherwise the result of statistical inquiry will be of little use and may even become quite misleading.

FRANZ BOAS.

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*ON THE TRUE NATURE OF TAMIOSOMA.**

IN 1856 the late T. A. Conrad described a remarkable fossil from California, under the name of *Tamiosoma gregaria*, composed of large tubes with a longitudinal cellular

*Communicated by permission of the Director of the U. S. Geological Survey.

structure, closed and tapering to a relatively small point of attachment below, nearly filled with a vesicular mass of shell laminæ internally, preserving a smooth-walled body cavity with a reflexed margin at the upper end, without any trace of subdivision in the walls, or dentiform processes. He pointed out some similarities in the form of the aperture to the sessile barnacles (*Balanus*) from which animals the undivided tube structure seemed to definitely separate the new organism. Subsequently he described an imperfect specimen as a *Balanus* (*B. estrellanus* Conrad, 1857), but still later (1864) he referred it to *Radiolites*, in the course of some rectifications of his earlier papers, and stated that it was characteristic of the Cretaceous of California.

In 1866 Gabb stated ('Pal. Cal.,' II., p. 62) that it was a fossil of 'the Bituminous shale, the best marked member of our Upper Miocene,' and referred it to the Hippuritidæ, an opinion provisionally accepted by Stoliczka in 1871,* notwithstanding the fact that the upper valve was unknown and the supposed lower valve showed no traces of muscular impressions, pallial line or tooth sockets. Tyron,† in 1884, copies Gabb's remarks without comment. Zittel‡ and Barrois, in 1887, regarded it as a problematical organism possibly referable to the corals, while in the same year Fischer expresses the opinion§ that it is more like a large barnacle than a Hippurite. Most of the manuals and check-lists prudently omit all reference to it.

During the past season Mr. Homer Hamlin of Los Angeles sent to the writer a collection of fossils from southern California containing numerous Miocene types, including *Lyropecten magnolia* and *L. Heermanni* Conrad, from a horizon of which the matrix is a cemented calcareous gravel (not the bituminous shale), containing several examples of *Tamiosoma;* not only the gregarious colonies, such as were described by Conrad, but also solitary individuals and certain flat saucer-like, concentric valves with reflected edges, which were naturally taken to be the long-sought upper valves. One solitary individual appeared to have this flat valve *in situ* and a sagittal section of it was made, to study the relations of the body cavity. It may be mentioned in passing that all the material in the beds from which these fossils came has been more or less crushed so that perfect specimens are extremely rare.

The result of the sectionizing was most unexpected. There was no body cavity and the flat saucer-like portion proved to be merely the basal portion of the tube, which in solitary individuals starts from an extremely small point of attachment to some object and grows concentrically in a flat form until it is an inch or two in diameter, after which it changes its manner of growth and rises in columnar fashion. In the gregarious groups the growth forms an inverted cone, owing to the mechanical difficulties in the way of lateral expansion. A section of the shelly matter showed that it is entirely destitute of the prismatic layer of the *Hippuritidæ*, and that the structure of the shell is precisely that of the sessile cirripedes. Since the tube is entire and not divided into valves, and is quite destitute of any radial structure, it was evident that the organism is not homologous with the valvular case of the sessile barnacles, which is always divided into plates more or less distinctly fused with one another, and that it cannot be a coral.

The only remaining alternative then appears to be that the fossil described by Conrad is homologous, not with the valvu-

*'Cretaceous Pelecypoda of India,' p. 239.

†'Structural and Systematic Conch.,' III., p. 206.

‡'Traité de Pal.,' II., p. 86.

§'Man. de Conchyl.,' p. 1064.

lar portion of *Balanus,* but with the base, which in the latter genus is not only entire, but under suitable conditions assumes a tubular conical form, and in one species, the *Balanus lævis* of Darwin, sometimes has the lower portion of this tube more or less filled with a vesicular mass of shell substance closely resembling the tube of *Tamiosoma.** This conclusion was fortified by the discovery of an undoubted species of *Balanus* in the same horizon as that of *Tamiosoma,* forming a tubular base like that of *B. lævis,* though much smaller, in the proximal portion of which a certain amount of vesicular filling had taken place. Lastly, complete confirmation was attained through the kindness of the authorities of the State Mining Bureau of California which at the intercession of Dr. J. C. Merriam, of the University of California, forwarded a unique specimen which had been supposed to exhibit an 'upper valve,' but in which the subconic base filled this rôle, while a careful cleaning of the much-crushed but otherwise nearly intact 'base' revealed the remains of six very solid valves typical of the genus *Balanus,* and the cavity, now filled with gravel and fragments of the shell, in which the soft parts of the animal had originally been enclosed. These valves were so crushed and worn that a complete figure of the valvular summit of *Tamiosoma* is not yet attainable, but the fact that the valves are smooth, except for the rude concentric rugosities due to resting stages and other exigencies of growth, and that they agree with the typical *Balanus* in number and general character, is conclusively demonstrated.†

It is interesting to discover new types of animal organisms, but perhaps still more so to be able to place those already known to some extent, but whose relations, in the absence of complete information, have been so differently estimated as in the present case. It only remains for systematic students of the cirripedes to determine whether the notable peculiarities of growth of this singular fossil warrant the retention of the name *Tamiosoma* in a subgeneric or sectional sense, or whether it shall be relegated to the genus *Balanus* as a synonym.

Some time since, the supposed occurrence of *Radiolites* in a bed of clay pierced for a tunnel in the city of Los Angeles was noted in SCIENCE. A further examination of fossils collected from these clays by Mr. Hamlin shows that sixty per cent. of the mollusks are recent species, and the age of the deposit therefore Pliocene. Mr. T. W. Vaughan is confident that the fossil which was taken for the smaller valve of the supposed *Radiolites* is a solitary coral; and, while the other portion still remains problematical, it is highly improbable that it belongs to the group of Rudistes.

WM. HEALEY DALL.

*Darwin, Mon. Cirripedia, *Balanidæ*, p. 227, 1854. See figure of the variety *coquimbensis*, Plate 4, Fig. 2a, giving a section of the tubular base, partly filled with vesicular septa.

†Since the above was written a letter from Mr. Hamlin announces the discovery of a number of complete specimens with the valves.

*THE RELATIVE PROGRESS OF THE COAL-TAR INDUSTRY IN ENGLAND AND GERMANY DURING THE PAST FIFTEEN YEARS.**

THE coal-tar industry is the flower of the chemical industries. It represents the highest development of applied chemical research and chemical engineering, and a country which allows the most scientific branch of chemical industry to languish cannot expect to maintain preeminence

*From a paper by Arthur C. Green read before the British Association (Section of Chemistry) at the Glasgow Meeting, 1901. This accurate statement of the present status of the coal-tar industry, and incidentally of the whole chemical industry, is of interest, not only to the audience for which it was prepared, but also to Americans. For this reason the most important portions of the paper are here presented.

long in any simpler branch of chemical manufacture. Skill trained for attacking the difficult problems of organic chemistry is certain, sooner or later, to be brought to bear on the simpler problems, and to result in improvements along the whole line of chemical industry, resulting in better products and cheaper production. This is well exemplified in the recent revolution in the manufacture of sulfuric acid. The manufacture of alizarin colors and artificial indigo has made a strong demand for cheap sulfur trioxid. With the object of satisfying their own requirements in this respect, the Badische Anilin and Soda Works of Ludwigshafen devoted much time and research to improving the catalytic process of Winkler. This endeavor was attended with such success that by means of the process and plant which they finally evolved they were enabled to produce sulfur trioxid so cheaply that it could not only be used for a large variety of purposes, but, by combination with water, afforded a profitable source of sulfuric acid. This new method of manufacturing sulfuric acid is, for concentrated acid at least, cheaper than the chamber process, and since the product is absolutely free from arsenic and can be produced at any desired concentration, it seems likely to supplant eventually the time-honored method of manufacture.

Besides exerting a stimulating influence upon the inorganic chemical manufactures, the coal-tar industry has given birth during recent years to several important daughter industries. The manufacture of synthetic medicinal agents, artificial perfumes, sweetening materials, antitoxins, nutritives and photographic developers, are all outgrowths of the coal-tar industry, and in great part still remain attached to the color works where they originated. The requirements of the coal-tar industry have further led to great advances in the design and production of chemical plants, such as filter-presses, autoclaves, fractionating columns, vacuum-pumps and stills, suction-filters, enameled iron, aluminum and stoneware vessels, etc., for the supply of which extensive works have become necessary.

Lord Beaconsfield said that the chemical trade of a country is a barometer of its prosperity, and it has always been regarded as a most important branch of English manufactures. Even those who might be inclined to regard our declining position in the color industry with more or less indifference would consider the loss of a material portion of our general chemical trade as nothing less than a national calamity. The two are, however, indissolubly connected.

It is with the object of ascertaining our present and future prospects in the chemical trade of the world that I propose to compare the relative development of the color industry in England and Germany during the past fifteen years. In 1886, in a paper read before the Society of Arts, Professor Mendola gave a masterly account of the position of the industry in this country at that date, and sounded a warning note to our manufacturers and business men regarding its future progress. These warnings, repeatedly given, have remained largely unheeded, and if the conclusions now forced upon us are unfortunately not of a reassuring nature for our national trade, it is well to remember that nothing is gained by burying our heads in the sand.

In no other industry have such extraordinarily rapid changes and gigantic developments taken place in so short a period —developments in which the scientific elucidation of abstract problems has gone hand in hand with inventive capacity, manufacturing skill, and commercial enterprise; in no other industry has the close and intimate interrelation of science and practice been more clearly demonstrated.

From 1858 to 1886 may be called the 'rosanilin period' of the color industry, since it was chiefly marked by the development of the colors of this group. A few individual members of other groups had been discovered, but had not attained importance. This is especially true of the 'azo' dyes, which have attained such importance that the last fifteen years may justly be called the 'azo period.' The number of individual compounds belonging to this class which have either been prepared or are at present preparable, runs into many millions, and far exceeds the members of all other groups of coloring matters put together. In commercial importance, also, they occupy a position at present far in advance of any other group; the employment of some of them, as the azo blacks, amounting to many thousands of tons annually. A great stimulus to the investigation of the azo compounds was given by the discovery by Boettger in 1884 of the first color possessing a direct affinity for cotton (Congo red), which was followed in a few years by a rapidly increasing series of colors of all shades having similar dyeing properties. The great simplification of cotton dyeing, brought about by the introduction of the new group of azo colors —'benzo' or 'diamin' colors as they are called—led to a rapid increase of their number. Simultaneously therewith proceeded the discovery and investigation of the various isomeric derivatives of naphthalene, required as raw products for the preparation of these colors.

Another method of applying azo colors to cotton, by which much faster shades are obtained, was introduced by Messrs. Read, Holliday & Co., of Huddersfield, in 1880, and consisted in producing unsulfonated azo compounds on the fiber by direct combination. Owing to technical difficulties this process has only reached its full development during the last few years, and that at other hands than those of its discoverers. The most important color produced by this method is paranitranilin red, for which over two hundred tons of chemically pure paranitranilin are manufactured annually.

The search for direct cotton colors led the author to the discovery of primulin in 1887, and this can be used for the synthesis of various azo colors on the fiber, which are remarkable for great fastness in washing. The new principle of dyeing which this introduced has been considerably extended in other so-called 'diazo' colors. The mordant azo colors have also, with the growing demand for faster shades, recently come into much prominence. The laborious scientific investigations of Fischer and Hepp, Bernthsen, Kehrmann and others on the azins, oxazins, and thiazins, have led to the discovery of many valuable new members of these classes, such as the indulins, rosindulins, rhodulins, etc. Much investigation has also been given to the pyrone and acridin groups, leading to the rhodamins, a class of pure basic reds, and to the basic yellows and oranges.

Next to the azo group, it is in the alizarin group that the greatest progress must be recorded. The demand for fast colors for calico-printing and for dyeing chrome-mordanted wool to withstand severe milling operations, has led to a long series of investigations and patents for producing new derivatives of anthraquinone—the anthracene and alizarin colors. The 'Vidal' blacks and other colors, for the direct dyeing of unmordanted cotton, are now being rapidly developed, although thus far their constitution has resisted elucidation.

It may be fairly claimed, however, that the greatest triumph of the coal-tar industry for the past fifteen years has been the successful production of artificial indigo on a large manufacturing scale.

Returning to the economic aspect of the subject, I will ask you to consider what

share we have obtained in the great expansion of trade resulting from all these new discoveries, of which many have originated in this country. The development of the industry in Germany is well illustrated by the following figures:

Exports from Germany to the World.

	1885. Tons.	1895. Tons.	1899. Tons.
Anilin oil and salt.....	1,713	7,135	.....
Coal-tar colors (excl. of alizarin)	4,646	15,789	17,639
Alizarin colors.....	4,284	8,927	.....

The value of the exports of coal-tar colors from Germany in 1894 was 2,600,000 pounds sterling, in 1898 3,500,000 pounds, an increase of nearly a million in four years. The total annual value of the industry of Germany is hardly less than ten millions of pounds sterling. With the increase in the production of synthetic indigo it may be taken to-day to considerably exceed this figure.

One may well wonder what becomes of this enormous quantity of coal-tar products. According to the United States Consular reports the three and a half million pounds' worth of coal-tar colors exported by Germany in 1898 were consumed as follows:

The United States took...	750,000	pounds' worth.
The Unted Kingdom took.	750,000	" "
Austria and Hungary took	350,000	" "
Italy took.....	225,000	" "
China took.....	270,000	" "

whilst the rest of the world took the remainder.

The great increase in production in Germany is further shown by the growth in the capital and number of work-people employed. Thus, according to a report of the Badische Works recently issued, the capital of this company, which was increased in 1889 from 900,000 pounds to 1,050,000, will be further augmented this year by the issue of 750,000 pounds' worth of bonds. The number of work-people employed by this company in 1900 was 6,485, as against 4,800 in 1896, an increase of over thirty-three per cent. in four years. The firm of Leopold Cassella & Co., of Mainkur, near Frankfort, have increased the number of their work-people from 545 in 1890, to 1,800 in 1900.

In England we find that the imports of coal-tar colors are steadily rising, having increased from 509,750 pounds sterling in 1886 to 720,000 pounds in 1900. Contrasted with this, the exports of coal-tar colors manufactured in England have fallen from 530,000 in 1890 to 366,500 pounds sterling in 1899. It is therefore apparent that we have had little share in the great increase which this industry has experienced during the past fifteen years, and we have not been able even to supply the expansion in our own requirements. This is well shown by the following statistics of the two Associations who together form a very large proportion of the entire dyeing trade.

Coloring-matters Used by the Bradford Dyers' Association.

English	10 per cent.	Swiss	6 per cent.
German	80 per cent.	French	4 per cent.

Coloring-matters Used by British Cotton and Wool Dyers' Association.

Anilin colors.....	English	22 per cent.
	Foreign	78 per cent.
Alizarin colors.....	English	1.65 per cent.
	Foreign	98.35 per cent.

Out of a total of sixty tons of coloring-matters and other dyeing materials derived from coal-tar, used by the English Sewing Cotton Company, only 9 per cent. were of English manufacture.

The following table gives a fair picture of the present dimensions of the industry in Germany.

Compared with such figures as these, the English color manufacture assumes insignificant proportions. The total capital invested in the color industry in this country does not exceed 500,000 pounds, and the

POSITION OF THE SIX LARGEST COLOR WORKS IN GERMANY IN THE YEAR 1900.

	Badische Anilin Works.	Meister, Lucius and Brüning.	Farben Fabriken Bayer and Co.	Berlin Anilin Co.	Cassella and Co.	Far werk Mühlheim Leonhardt, and Co.	Total of Six Firms about.
Capital	£1,050,000	£833,000	£882,000	£441,000	Private concern	£157,000	£3,500,000
Number of Chemists	148	120	145	55			500
Number of Engineers, Dyers and other Technologists	75	36	175	31	60	450	350
Commercial Staff	305	211	500	150	170		1,360
Work People	6,485	3,555	4,200	1,800	1,800		18,260
Dividends (per cent.)							
1897	24	26	18	12½	not known	9	
1898	24	26	18	15	" "	3	
1899	24	26	18	15	" "	5	
1900	24	20	18	?	" "	nil	

total number of chemists employed cannot be more than thirty or forty.

A similar relative proportion is maintained in patents:

Comparison of Number of Completed English Patents for Coal-tar Products taken during 1886–1900 by Six Largest English and Six Largest German Firms.

German firms:	
Badische Anilin Works	179
Meister, Lucius and Brüning	231
Farbfabriken Bayer & Co.	306
Berlin Anilin Co	119
L. Cassella & Co	75
Farbwerk Mühlheim Leonhardt & Co.	38
Total of six German firms	948
English firms:	
Brook, Simpson & Spiller	7
Clayton Anilin Co	21
Levinstein	19
Read Holliday & Co	28
Claus & Reë	9
W. G. Thompson	2
Total of six English firms	86

Nor does this represent the sum total of our losses. The new coloring matters, made chiefly in Germany, have in many cases been introduced as substitutes for natural products, which were staple articles of English commerce. Madder and cochineal have been replaced and logwood and indigo are seriously threatened. The capture of the indigo market by the synthetic product, which would mean a loss to our Indian dependencies of three million pounds sterling a year is regarded by the Badische Company as so absolutely certain, that having already invested nearly a million pounds in the enterprise, they are at present issuing 750,000 pounds of new bonds to provide funds to extend their plant for this purpose.

Again, besides the loss of material wealth which the neglect of the coal-tar trade has involved to the country, there is yet another aspect of the question which is even of more importance than the commercial one. There can be no doubt that the growth in Germany of a highly scientific industry of large and far-reaching proportion has reacted with beneficial effect upon the universities, and has tended to promote scientific thought throughout the land. By its demonstration of the practical importance of purely theoretical conceptions, it has had a far-reaching effect on the intellectual life of the nation. How much such a scientific revival is wanted in our own country the social and economical history of the past ten years abundantly testifies. For in the struggle for existence between nations the battle is no longer to the strong in arm, but to those who are the strongest in knowledge to turn the resources of nature to the best account.

In 1886 it could perhaps still be maintained that we held the key to the situation if we chose to make use of it; inasmuch as the principal raw products of the color industry (tar oils, naphthalene, anthracene, soda, ammonia, iron, etc.) were in great measure imported from England. In 1878 Professor von Bäyer had said: "Germany, which in comparison with England and France possesses such great disadvantages in reference to natural resources, has succeeded by means of her intellectual activity in wresting from both countries a source of national wealth. The primitive source of this wealth is in England. It is one of the most singular phenomena in the domain of industrial chemistry that the chief industrial nation, and the most practical people in the world, have been beaten in the endeavor to turn to profitable account the coal-tar which they possess. We must not, however, rest upon our oars, for we may be quite sure that England, which at present looks on quietly while we purchase her tar and convert it into colors, will unhesitatingly cut off the source of supply as soon as all technical difficulties have been surmounted by the exertions of German manufacturers."

But the initial advantages which our natural resources afforded us have been neglected, and now, in 1901, the conditions are completely changed, and Germany is no longer dependent upon England for her raw material. Through the shortsightedness, ignorance, and want of enterprise of those with whom rested the care of the color industry of this country in its earlier days, the opportunity has been allowed to pass forever. The English manufacturer considered that a knowledge of the benzene market was of far greater importance than a knowledge of the benzene theory, and little encouragement was given here to chemical investigators and discoverers. The control of the industry passed into the hands of men who had no knowledge and absolutely no appreciation of the science upon which their business rested, and concerned only with getting the ultimate amount of present profit, discouraged all scientific investigations as waste of time and money. The chemist who devoted himself to the elucidation of the chemical constitution of a coloring matter was regarded by them as an unpractical theorist of no value to a manufacturing business. Even when he discovered new coloring matters of commercial value, they were so blind to their own interests and so incapable of believing that any practical good could come out of such theoretical work, that in many cases they refused to patent or in any way take advantage of the discoveries made by him.

During recent years this attitude has certainly undergone considerable modification. Certain firms must indeed be given the credit of endeavoring to pursue a more enlightened policy, but these attempts have always been directed too much in the expectation of realizing immediate financial results. The difficulties which must be encountered in an attempt to regain the lost ground are of necessity very great and quite unappreciated by our business men. It seems, in fact, to have been the opinion of the public and of the average financial man that this industry ought to be easily won back by the establishment of a few technical schools, the engagement of a dozen chemists, and the investment of a few thousand pounds in new plants, forgetting that the supremacy of our German competitors has been won by years of patient toil, by the work of hundreds of trained chemists, and by the outlay of millions of capital. Who can be surprised, therefore, if such expectations have not been realized, and if in spite of some notable successes the general position of the color trade in England to-day presents a gloomy aspect?

Where, then, are we to look for an improvement? Some would find a remedy in the imposition of heavy protective tariffs, but such tariffs in France have not availed to prevent a similar state of things there, and protection in coloring matters might have a very detrimental effect upon the textile industries of the country. Others expect salvation from the extension of technical schools, but laudable as is the aim of these institutions, I cannot see how they can effect much until their raw material is of a very different character from what it is at present, and until the public can be completely disabused of the fallacy that a year or two of technical training pumped into an ignorant schoolboy will produce a better works-chemist than a university course of scientific study laid upon the foundation of a good general education.

The remedy for the present state of affairs must of necessity be a slow one, and in my opinion can only be found in a better appreciation of the value of science throughout the length and breadth of the land. Until our government and public men can be brought to realize the importance of fostering the study of science, and of encouraging all scientific industries, until our schools and universities appreciate the importance of a scientific education, until the rewards for public service in science are made equal to those in other branches of public service, so long will science continue to be held in insufficient esteem in our country. It is not so much the education of our chemists which is at fault as the scientific education of the public as a whole.

When our capitalists more completely realize the importance of calling in the aid of the best scientific skill available, when our universities and technical schools are able to supply a sufficient number of highly educated chemists equal in knowledge, originality and resource to those trained in German universities, when our professors and manufacturers are willing to work together in this and other matters, when our patent laws are rendered just to ourselves, we may confidently hope that our natural engineering skill and practical resource will once more bring us to the front.

CONCERNING CERTAIN MOSQUITOES.

DURING the season of 1901 the writer studied the mosquito problem, as it exists in the State of New Jersey, with a view to determining whether it was possible in any way to reduce or control the number of these pests in the State. It was decided that the first point of importance was to ascertain just what species was or were the most troublesome, and just where these troublesome species bred. Collections were made in all parts of the State and local boards of health were enlisted in the service everywhere. The result was the accumulation of a large amount of material, covering every county and almost every district in the State.

Based upon these collections, it was found that the most abundant species was *Culex sollicitans,* and, after this fact was determined, especial attention was paid to the life history and breeding places of this mosquito. It has been known that the species breeds in brackish water; but it has been believed, and is so stated by Dr. Howard in his book on mosquitoes, that it would not breed in water as salty as the sea itself. Collections made along shore soon proved that this general belief was incorrect: so far as noted the contrary is true, for larvæ were found in great abundance in pools and ponds in which the water was fully twenty-five per cent. more salty than ordinary sea water. The collections in the marshes along the coast demonstrated that some percentage of salt was absolutely necessary for the development of the larvæ. In no case were

they found in fresh water, even where adults occurred in enormous quantities. This was prettily illustrated on the Elizabethport meadows, from which the cities of Newark and Elizabeth get the greatest proportion of their mosquito supply during the summer. A large portion of these meadows is flooded during extra high tides, or during storms; a number of fresh water creeks run through them and rapidly freshen these salt-water-covered areas. This is especially true during the latter part of the summer after a period of moderate tides. A two days' collecting trip by an assistant failed to develop any larvæ of *sollicitans* until the shore edge of the meadows was reached, where the puddles were distinctly salty. Everywhere else, while there were plenty of other larvæ discoverable those of *sollicitans* were entirely absent. After a heavy storm causing an unusually high tide, which flooded the meadows, collections were again made and now, as salty water was found almost everywhere, there was no difficulty in obtaining larvæ of *sollicitans*. Every attempt was made to secure *sollicitans* larvæ from fresh water; but almost without success, even where the insects occurred in swarms. I feel no hesitation in claiming that under natural conditions the larva of this species is never found in fresh water; unless it is in a pool that was salty when the eggs were laid and has been freshened subsequently by rains, or otherwise.

Another fact was established by observations made during the summer: that is, the species will travel long distances from its breeding places. For miles throughout South Jersey the only species of mosquito found in any numbers is *Culex sollicitans*. On the cranberry bogs on which I spent some time countless thousands of these insects occurred. The breeding conditions for mosquito larvæ were almost ideal and plenty of larvæ were found, but none were of this species. All the specimens observed were females; males apparently do not go away from their natural breeding places. Twenty miles back from the coast, *sollicitans* is the dominant species and occurs most of the summer. Forty miles from the coast occasional flights occur; but their period is short, rarely lasting more than a week or ten days, and there may not be more than one or two of them during the season. From observations made and information gathered along shore and back from it for some distance, it seems certain that large swarms rise during favorable evenings and are carried during the night by the wind for varying distances. The direction is determined by the direction of the wind, and may be as often out to sea as inland. Swarms have been met with fifteen miles from shore, and are common five miles from shore. These are usually if not always lost. This migration, if that term can be properly employed, is contrary to previous beliefs, my own included, and is an important factor in the question of the control of mosquitoes in the State. It takes it out of the rank of local problems and makes it a State affair. It is quite obvious that no methods adopted at a point where these mosquitoes do not breed can prevent their abundance when the wind is in the right direction to bring swarms of them from the sea coast. On the other hand, there seems to be no very great difficulty in deciding upon the character of the work that should be done to destroy the breeding places of these pests. The measures are largely of a permanent character. They consist partly of draining, partly of ditching and partly of opening ways for the free entrance of tides, and with them of certain species of small fish that feed on mosquito larvæ. At a comparatively small expense considerable areas can sometimes be freed of breeding places. Much has been done by private enterprise at seashore resorts and there will be no difficulty in se-

curing cooperation in any work that the State may undertake or may suggest.

The next species in abundance is *Culex pungens*. The history of this species has been so well written that little remains to be added to it. It is the one species of *Culex* of which we know positively that it hibernates in the adult stage. It breeds everywhere in almost all sorts of places, provided only there is water which is not salty. I have never found it in salt water; but in other respects it is not particular. It breeds in cesspools, sewage water and even in manure pits. It has no objection to remaining indoors, and the larvæ will swarm in a neglected bucket just as readily as they do in a half-filled tin can on a dump. The only point of particular interest noted in connection with this species is the fact that it breeds much later in the season than has been believed. Active larvæ were found until late in November, and even less than half-grown forms were seen at that time, indicating a comparatively recent oviposition. As against this species local work is necessary and effective; but it is far from necessary to treat indiscriminately all sorts of bodies of water. There are some places where even this insect will not breed, and unless information is generally distributed concerning the places that actually need treatment, a good deal of work will be wasted and unnecessary expense incurred.

Some very interesting information concerning the species of *Anopheles* has been gathered. It has been known that these species hibernate as adults; the places where they hibernate in the woods have been discovered; the general character of the breeding places has been established and it has been found that the larvæ may be found in salt water as well as fresh. This has been asserted of a European species but was doubted by Dr. Howard for our own. It has been also found that these insects continue to breed until long after frost has set in. Larvæ and pupæ were taken from ponds that had been completely ice covered. On at least three separate occasions adults were bred from larvæ and pupæ after they had been confined in or under ice for a period of several hours. It is demonstrated beyond peradventure that mere cold or even an ice covering is not fatal to larval or pupal life of *Anopheles*. It is further indicated from the researches made that there is absolutely no connection between the abundance of *Anopheles* and the prevalence of malaria. In a limited district where malaria as an original disease is unknown, over two thousand specimens of *A. punctipennis* were taken from the cellar under a moderate-sized farm-house. From the outbuildings as many more were captured, in October and November. Altogether about this one group of farm buildings fully five thousand specimens were actually taken during the two months mentioned. This is, therefore, one of their commonest mosquitoes; yet patients afflicted with malaria have come there, away off in the woods, to get well; and they did so, without leaving in their trail a wake of malarial cases. I do not wish to be understood as doubting the connection between *Anopheles* and malaria, nor that the mosquito is necessary as an intermediate host in the development of the pathogenic organism. I wish only to say that my investigations point to the fact that there is some other factor involved and that, even in the presence of an existing case of malaria, *Anopheles* is not able to transmit the disease to a healthy individual, unless certain other conditions favor the transmission or the development of the malarial organism after it is introduced into the healthy subject.

JOHN B. SMITH.

RUTGERS COLLEGE,
Dec. 6, 1901.

UNIVERSITY REGISTRATION STATISTICS.

A KNOWLEDGE of the present condition of the status of higher education in the United States may be gleaned from the accompanying table, wherein are enumerated statistics relating to the registration at seventeen of the leading universities in the country, both East and West. These figures have been obtained from the proper officials of the institutions concerned, and are as correct as statistics of this nature can be made. With but slight exceptions, these figures are approximately as of November 1, 1901.

The gain or loss in the enrollment in the various departments of the universities enumerated are indicated in each instance, where obtainable, by figures within parentheses. These figures have been revised, and may not tally exactly with the figures to be found in SCIENCE published on December 21, 1900. The enrollment figures for the University of Nebraska are for the first time included in this table.

	California.	Chicago.	Columbia.	Cornell.	Harvard.	Indiana.	Johns Hopkins.
College Arts, Men	2099 (49)	494	481 (17)	817 (73)	1983 (—9)	660 (100)	163 (—15)
College Arts, Women		535 (54)	326 (34) §		452 (3) ‖	385 (65)	.....
Scientific Schools *		.....	601 (61)	1017 (134)	549 (42)	.....	.....
Law	100 (—21)	.....	441 (14)	197 (21)	628 (—19)	135 (10)	.....
Medicine	161 (—10)	257 (?)	800 (49)	415 (79)	506 (—99)	.....	227 (16)
Agriculture	†	.....	.....	86 (—5)	32 (—1)	.....	.....
Art	178 (—30)	.....	.....	.....	.....	.....	.....
Dentistry	141 (—11)	.....	.....	.....	105 (—21)	.....	.....
Divinity	.....	192 (12)	.....	.....	37 (9)	.....	.....
Forestry	.....	.....	.....	38 (16)	.....	.....	.....
Music	.....	.....	.....	.....	.....	.....	.....
Pharmacy	85 (1)	.....	.....	.....	.....	.....	.....
Teachers College	‡	95 (?)	526 (78)	.....	.....	.....	.....
Veterinary	.....	.....	.....	51 (10)	.....	.....	.....
Graduate Schools	168 (13)	404 (74)	472 (60)	183 (—9)	312 (—29)	51 (11)	169 (9)
Courses for Teachers	.....	.....	400 (—279)	.....	.....	50 (?)	.....
Summer Session	799 (366)	1750 (—40)	579 (162)	424 (—21)	982 (—5)	453 (120)	.....
Other Courses	.....	.....	18 (—2)	.....	.....	233 (?)	97 (16)
Deduct double regist.	[191]	[?]	[222]	[?]	[10]	[?]	[1]
Grand Total	3540 (319)	3727 (—47)	4422 (225)	3216 (313)	5576 (—148)	1967 (?)	655 (25)
Teaching Staff	250	202	466	387	495	78	139

While statistics of this character may not be exactly the same for two weeks in succession, as those engaged in university administrative work well know, nevertheless such figures are general enough in import to indicate the trend of the advancement of higher education in various sections of the country. Changes in curricula, stiffening of entrance requirements, and the inauguration of new policies, materially affect the enrollment statistics of any university.

Particular attention is called to the effect of the introduction of the new entrance requirements to the Harvard Medical School. The demand of four years' liberal training in a college previous to entrance upon the work of the Harvard Medical School has resulted in a loss of almost 100; but this change will inevitably result to the advantage of the Harvard Medical course.

Attention is also called to the increased enrollment in the summer sessions of both our eastern and western universities.

While there has been a falling off in the grand total of attendance on some of the universities tabulated, there has at the same time taken place a steady forward movement in the progress of higher education,

* Includes schools of engineering, chemistry, architecture, mines and mechanic arts.

† Included in scientific schools.

‡ Included in college.

§ Barnard College.

‖ Radcliffe College.

as revealed by these statistics of attendance.

GEO. B. GERMANN.

SCIENTIFIC BOOKS.

Die Entwicklung der Biologie im 19. Jahrhundert. Vortrag auf der Versammlung deutscher Naturforscher Zu Aachen am 17. September, 1900, gehalten von OSCAR HERTWIG. Jena, Gustav Fischer. Pp. 31.

The advancement in knowledge of organic nature was so remarkable during the nineteenth century that it is of unusual interest to have the progress in biology summed up by one of the leaders in the movement. As might be expected from Hertwig's well-known powers of clear exposition, the reading of this lecture is enjoyable; the line of thought is not difficult to follow and the analysis of the subject is as simple and direct as it is possible to make it within the limits of thirty-one pages. It is, of course, impossible in many instances to do more than suggest the line of influence of a group of men whose work has been of epoch-making importance. The names of most of the great leaders are mentioned categorically—and the list is a long one, but it is a disappointment to miss any reference to Bichat. His influence was so considerable on the development of minute anatomy in the nineteenth century that, notwithstanding the fact that he met his early and untimely death in 1802, his should be recognized as one of the great influences in the development of biology in the nineteenth century. The omission of the name of any American investigator is more in the nature of a blunder. However clear the general account of biological progress may be, it is inadequate if no place is found in it for such names as Cope, Marsh and Gray or for the mention of the embryological and cytological researches of American investigators.

The subject is naturally considered under two main divisions—the progress in morphology and that in physiology. In regard to progress in morphology, the four following factors are indicated as having had the greatest influence: (1) The establishment of the cell theory and the closely related protoplasm doctrine. (2) The development of the science of bacteriology. (3) Progress in embryology. (4) The doctrine of organic evolution.

The great influence of the cell theory is especially emphasized, not only as to its unifying tendency in uniting animals and plants on the broad basis of similitude of structure, but also as opening to naturalists the real problems of the living organism. The dis-

Leland Stanford.	Michigan.	Minnesota.	Missouri.	Nebraska.	Northwestern.	Pennsylvania.	Princeton.	Wisconsin.	Yale.
675 } (—71)	655 (17)	489(—2)	} 456(?)	374	323 } (—15)	453 (32)	773(28)	} 869	1236(44)
432 }	598 (7)	638(46)		533	272 }	.....	.....		.....
*	472 (119)	439(78)	417(?)	369	.....	355 (19)	466(38)	639	624(14)
*	821 (12)	490(27)	137(22)	145	175 (0)	376 (32)	.....	245	246(36)
.....	474 (—43)	386(29)	86(4)	14	408 (4)	538 (28)	.....	.....	148(15)
.....	.....	605(61)	53(—35)	58	64 (5)	.....	.....	18	.....
.....	.....	.....	.....	38	.....	....	.....	.....	66(—9)
.....	200 (—78)	104(—2)	.....	.....	541 (51)	361 (54)	.....	.....	.....
.....	.....	.....	.....	.....	155 (0)	.....	.....	.....	98(9)
.....	.....	.....	.....	.....	.....	.....	.....	.....	30(23)
.....	.....	.....	.....	238	261 (60)	.....	.....	108	69(—57)
.....	62 (—7)	73(3)	.....	.....	184 (20)	.....	.....	30	.....
.....	.....	.....	123(64)	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	72 (15)	.....	.....	.....
73 (—11)	93 (17)	170(—7)	39(4)	86	.....	180 (10)	123(45)	115	329(30)
.....	.....	.....	.....	.....	.....	185(—45)	.....	.....	.....
48 (—8)	418 (14)	302(27)	507(68)	256	.....	.....	.....	375	.....
.....	64 (—10)	.....	.....	21	.....	0(—10)	....	466	.....
[?]	[41]	[160]	[269]	[229]	[18]	.....	.....	[53]	[166]
1228 (—90)	3816 (64)	3536(113)	1549(214)	1903	2365 (125)	2520(—29)	1362(111)	2812	2680(178)
164	239	260	?	?	244	270	90	170	290

* Included under College. 170 students in law are enrolled; loss of 15.

covery that fermentation, putrefaction and finally, that many diseases are due to micro-organisms, stimulated studies which led to the establishment of the science of bacteriology. The revival in the nineteenth century of the question of spontaneous generation is mentioned, and the great triumph of Pasteur in demonstrating the falsity of the position of the heterogenists. Here also one notes another omission—no reference is made to the luminous researches of Tyndall on this subject with optically pure air. The great influence of embryology as founded on the work of Pander and von Baer is sympathetically although briefly treated. The facts that all animals begin as single cells, and show every gradation between that simple condition and the more complex one of the adult, and that ontogeny is in a sense an epitome of phylogeny, are sufficiently striking to endue this subject with unusual interest. Lastly, the influence of the establishment of the theory of evolution is spoken of.

In physiology the fundamental importance of experiment is pointed out—what the microscope is for anatomy, experiment is for physiology. Among the greatest advances mentioned in the first half of the century are the demonstration of Bell's law and the elaboration of the theory of specific energy by Johannes Müller. The development of physiology along the respective lines of chemical and physical physiology is discussed, together with the opposition aroused by these researches to the old theory of vitalism. The observations as to the action of chemical substances within the bodies of lower animals were turned to practical account in medicine. While physiology was being developed along chemical lines by one school, represented by Claude Bernard Pettinkofer, Voigt, Pflüger, Heidenhain and others, it was being advanced along physical lines by Robert Meyer, Helmholtz, Ludwig, Dubois-Reymond and others. With the latter school came exact methods of measuring and recording physiological activities, as with the kymograph, myograph, etc. The greatest triumph of the chemical and physical methods was in demonstrating that physiological processes are chemico-physical rather than vital. But this conception has been carried too far; some physiologists look upon life, with all its complex manifestations, as being entirely chemical and physical. This is as far wrong as the old theory of vitalism. The relation of the physicist to biological questions is similar to that of the chemist. Physiological questions can not be explained on purely chemical and physical grounds. We can not find out the rôle played by albumin in vital processes by study of its chemistry, but by direct study of the protoplasm in living cells. We must return to an anatomico-biological basis and let it be modified by the chemico-physical conception. The material world must be united by biological studies with the manifestations of the immaterial world of life.

William A. Locy.

Comparative Physiology of the Brain and Comparative Psychology. By Jacques Loeb. The Science Series. New York, G. P. Putnam's Sons. 1900. Pp. x+309. $1.50.

Professor Loeb's book forcibly calls attention to the importance of the comparative method in physiology and psychology. The present work is a translation, with additions and changes, of the German edition of 1900 by Mrs. Loeb. The book has been made into English with singular skill. It is clear, concise, scientifically accurate in statement, and, withal, readable. Of it may truthfully be said 'every words counts.' Whether one agrees or disagrees with any or all of the conclusions reached, the discussion is valuable, for it pleads for opposition, contradiction, investigation. There are not so very many physiologists, we fancy, who will fully agree with all the theories which Professor Loeb seeks to maintain; fewer still are the psychologists who will find themselves in sympathy with his attitude, and among ethical thinkers scarcely any will come to the support of the new scientific construction whose possibility, nay, necessity—for our author is evidently a man of strong convictions—is hinted at. But opposition is needed for the testing of the theories in which the book abounds, although we doubt not that in the main the author's position is a safe one. Nothing is clearer than the seri-

ousness with which Professor Loeb takes himself and his work. Every sentence indicates that he realizes the importance of the study of life phenomena, and appreciates the intimate relationship of all physiological investigation to the practical problems of our work-a-day life.

The book is itself a collection of experimentall discovered facts of neural physiology so arranged that they inevitably lead the reader to the definite conception of the rôle of the nervous system held by the author. Noteworthy is the fact that a majority of the experimental studies from which evidence is drawn in support of the views presented have been made by Professor Loeb himself. They form, as thus gathered together, and unified by a single purpose, a splendid monument to the energy, patience and enthusiasm of a physiologist who has well earned the praises of the scientific world. To say of most physiologists 'he has based a general discussion of the function of the nervous system solely upon the results of his own researches,' would be equivalent to characterizing and condemning the work as narrow and incomplete. But of the work in question this cannot be said, for Professor Loeb's investigations have covered such a wide range of physiological and psychological phenomena, and his problems have been selected with such rare insight into the general implications and relative importance of different aspects of his chosen work, that they furnish an excellent foundation for the theories which he presents.

The conscious and avowed goal of Professor Loeb's researches is 'the control of life phenomena.' His slogan well might be 'more life and fuller that we want.' It is not simply to understand the functions of the organism for the sake or satisfaction of understanding, but that we may be the better able to regulate our lives that we should strive toward the control of vital processes. Toward this goal we are to progress by the use of the methods of physics and chemistry. To quote, "It seems to me that living organisms are machines and that their reactions can only be explained according to the same principles which are used by the physicist." On the basis of the physical and chemical qualities of protoplasm our author proposes to explain all activities.

'Comparative Physiology of the Brain and Comparative Psychology' may for review be divided into four parts. Of these the first deals with the relation of reflex action to the nervous system. Experimental evidence is presented to prove that such actions are not dependent upon any specific character of nerve tissue, but upon the general properties of protoplasm. This is followed by a consideration of the morphological and physiological evidence bearing upon the 'center theory' and the 'segmental theory' of the nervous system, with a defense of the latter. The third main subject is the relation of instinctive action to the rôle of the nervous system and to reflex action. Experiments are cited to show that the instinctive act is really only a chain of reflexes. Finally, in the portion of the book which comes under the title 'comparative psychology,' associative memory is pointed out as the psychic fact of prime importance. Its connection with brain functioning is discussed, and the possibility of analyzing all complex psychic phenomena into associative processes maintained.

It is common to refer all actions to nerve centers. Even the simplest reflex act is thought of by many as dependent upon the functioning of a ganglionic center. Now it is Professor Loeb's conviction that this is an erroneous view; and by an examination of experimental studies of representatives of the Cœlenterata, Echinodermata, Vermes, Arthropoda, Mollusca and Vertebrata he proves that reflexes can be executed in the absence of ganglia. A few of the instances mentioned in the book may be cited.

Study of the Medusæ has shown that the bell will make normal spontaneous, coordinated movements after the nervous system has been removed. Thus by a very simple experiment, spontaneity, coordination and reflex action are proved to be independent of the central nervous system.

Among the Ascidians, *Ciona intestinalis,* whose nervous system consists of a single ganglion, normally exhibits a peculiarly characteristic reflex in the closing of both the oral and aboral openings, when open, if either is

touched. If the ganglion be removed the animal will still carry out this reflex. But careful study shows that there are differences between the action of the normal animal and the one which lacks its ganglion. In the latter the threshold of stimulation is higher and the reaction-time greater. From this Professor Loeb concludes that 'the nerves and ganglion only play the part of a more sensitive and quicker conductor for the stimulus.'

The tentacles of *Metridium* in the food-taking activity of the animal move in such a way as to bring the object with which they are in contact to the mouth. The action is one of apparent adaptation, and one would scarcely expect to see the same kind of a reflex occur after the tentacle had been cut from the body. Such, however, is the result of the experiment; no difference between the action of the tentacle in normal relation to the nervous system and that which has been isolated is observable. We have to conclude, therefore, that the action is determined by the properties of the protoplasm of the tentacle itself, and not by special properties of the nervous tissues.

Other observations prove that certain worms when deprived of their brains are able to move spontaneously. As a case in point, the freshwater Planarian, *Planaria torva,* is sensitive to stimulation by light. To any increase in intensity it responds by movement. It also selects the darkest region of a dish in which it is left. When the anterior portion of the body is cut off it is found that the brainless portion will give the same responses to light as the normal animal. And the only significant fact in favor of the influence of the brain upon such activities is that the reaction-time of the brainless animal is longer.

Of the reflexes of higher animals that are known to be in part at least independent of the brain and cord are the movements of the iris, the bladder, rectum, blood vessels, respiratory organs, etc. Experiments upon fishes, frogs and dogs have established the independence of many of their reflexes. In one instance the whole brain and spinal cord of a larval frog were destroyed without interfering with spontaneous movements. There are so many observations of this kind for the vertebrates that one cannot question the general truth of Professor Loeb's conclusion. As he states, those instances in which the reflex is interfered with by the destruction of the nervous system are explicable by the fact that the only existing connection between the sense organ and the muscle has been broken. Establish any kind of protoplasmic connection between the region in which the disturbance arises and the motor apparatus, and the appropriate reflex will be executed.

But the fundamental experiment for the proof of the independence of reflexes is that made by Professor Loeb upon isolated muscles. He has shown that muscles containing no ganglion cells will beat rhythmically when placed in a pure sodium chloride solution of the same osmotic pressure as the blood. To put the matter in his words, "It is not the presence or absence of ganglion cells which determines the spontaneous rhythmic contractions, but the presence or absence of certain ions. Na ions start or increase the rate of spontaneous rhythmical contractions; Ca ions diminish the rate or inhibit such contractions altogether." Now it is clear that to prove the isolated muscle capable of responding to stimuli is to establish the thesis which has been stated.

The conception of the nervous system as a series of more or less intimately related centers, each with its own special function, arose and found an observational basis in the many experiments on localization. Certain parts of the brain apparently control certain groups of muscles. This is undoubtedly true, but Professor Loeb attempts to show that the conception as a whole is false. From comparative morphology and physiology comes abundant evidence of the segmental theory of the nervous system. In the Annelids, for example, the segments, each with its ganglion and nerves, are to a certain extent independent organisms. Each ganglion in this case functions in connection with a very definite portion of the worm.

"The so-called centers of the cerebral cortex are merely the places where the fibers from single segments of the central nervous system enter." If the spinal cord of a dog be cut it will be found, after the shock of the operation

has passed, that all of the reflexes belonging to the segments of the body which are represented by the portion of the cord severed can be executed. Rubbing of the skin causes scratching movements of the hind legs, and the reflexes of bladder, rectum and respiratory organs occur in response to the appropriate stimuli.

"According to the segmental theory," writes our author, "there are only indifferent segmental ganglia in the central nervous system, and the different reactions or reflexes are due to the different peripheral organs and the arrangements of the muscles. The center theory must remain satisfied with the mere problem of localizing the apparent 'seat' of a 'function' without being able to give the dynamics of the reactions of an animal, as the latter depend in reality upon the peripheral structures, and not on the structures of the ganglia. For this reason the segmental theory alone will be able to lead to a dynamical conception of the functions of the central nervous system."

In taking up the problem of instinct Professor Loeb touches a field which he has made distinctively his own; for no one has done so much as he toward the analysis and explanation of this type of action. He holds that there can be no sharp separation of reflex action from instinctive. The reflex usually is the activity of a single organ, and the instinctive act one in which the whole organism is concerned. Instinctive actions are characterized by an apparent adaptation to a special purpose, an adaptation to the circumstances in which they occur. For this reason there is a strong tendency to regard them as results of intelligence. For years Professor Loeb has been studying, and, as it were, dissecting, instinct after instinct in order to show the absurdity of this conception.

The fly that instinctively selects for the depositing of its eggs a substance on which the larvæ can feed does so not because it has a faint notion of the utility of the action, or even because it chooses so to do, but because the chemical particles emanating from the substance stimulate it in such fashion as to cause an orientation of its body in reference to the source of the stimulus, and this orientation in turn determines the movement toward the substance. The whole is simply a mechanical problem; physics and chemistry serve to explain the instinct.

An insect comes within the range of vision of a frog and is instinctively stalked, seized and swallowed. In this event the visual stimulus initiates a series of reflexes whose result is the obtaining of food. There is no deliberate choice, no intelligence in the action. The crustacean or insect or worm that instinctively moves toward a source of light does so, experiments indicate, simply because the light forces it to take a certain orientation, just as the chemical stimulus did in case of the fly. Once having taken this position, there is only the possibility of moving toward the source of the stimulus. The 'orientation theory' is one of Professor Loeb's chief contributions to the explanation of instincts. It is based upon the assumption that when a stimulus affects symmetrical points of an animal's body unequally there is resulting inequality of muscular activity on the two sides, and as a result the organism is finally forced into that position in which symmetrical points are equally stimulated. Such a position is evidently attained when the long axis of the body is parallel with the rays of light, for example, with the head either toward or away from the source of the light. From this position it is clear the animal can move only toward or away from the light.

And again it is noticed that certain arthropods and worms 'hide' in crevices. If we study this action we learn that the animals are able to remain quiet only when the body is in contact with some object, and so long as it is not in such a position the animal moves about continuously. In the act 'hiding' plays no part. The phenomenon is merely the inhibition of movement by a stimulus, it matters not whether the stimulus be given by a board which really 'hides' the animal or by a plate of glass which leaves it fully exposed to view. And so one might go on with the enumeration of simple instinctive acts that appear to be guided by reason, but whose careful study reveals only the influence of certain environmental factors upon a definitely describable organic structure.

To the most important of these environmental factors the name 'tropism' has been applied. Heliotropism is the response to light; chemotropism, to chemicals; galvanotropism, to electricity; stereotropism, to contact; geotropism, to gravity; hydrotropism, to moisture; thermotropism, to temperature, etc. All simple instinctive acts are found to be responses to one or more such factors either external or internal; those more complex actions of which nest building and the instinctive processes of ants, bees and wasps are representative are presumably due to a number of factors working simultaneously and giving rise to a series of reflex acts, the whole of which in their interconnection is an instinctive action. No one has yet succeeded in satisfactorily analyzing any of these complex activities, but Professor Loeb has confidence that the subjecting of any of them to laboratory requirements will reveal the same kind of structure as has been discovered in the simple acts.

The chapter on instinct closes with some remarks concerning the relation of the conception presented to ethics. "The analysis of instincts from a purely physiological point of view will ultimately furnish the data for a scientific ethics. Human happiness is based upon the possibility of a natural and harmonious satisfaction of the instincts." Such are the significant statements with which we are introduced to the author's ethical philosophy. From the naturalistic point of view ethics can have no other foundation than that indicated above; and there is no doubt that he who is only a physiologist can find complete satisfaction in it. But one feels, *instinctively,* that Professor Loeb, despite his unpleasant, though appropriate, introductory words concerning the mixing of metaphysical and scientific conceptions, is of a philosophic mind, and it seems probable that physiology alone saved him from becoming a technical metaphysician.

We find upon turning to the discussion of comparative psychology that Professor Loeb considers as the central and chief problem of the physiology of the central nervous system the study of the 'mechanisms which give rise to the so-called pyschic phenomena.' As the elemental psychic fact he names 'associative memory,' by which he means neither more nor less, so far as we can see, than what the psychologist designates as an associative process. Wherever associative memory is found there is material for the psychologist. His first task must be to determine in what animals this psychic phenomenon occurs, and his second, to analyze the more complex processes of higher animals into the elements of the psychic process, much as the instinctive act is analyzed into reflexes.

An animal which can learn is said to have psychic processes. In this criterion of associative memory is seen, by Professor Loeb, the basis of a future comparative psychology. Among vertebrates it is well known that associative processes are found; even the Amphibia and Fishes profit by experience, although it is stated by the author that the frog has not yet been proved to have associative memory. Of the invertebrates in this respect little is known for they have not been studied experimentally. But at present it seems safe to say the Cœlenterata and Vermes are not known to profit by training. By this criterion of the psychic a very sharp limit for the field of psychology is indicated. Those who do not believe in what Professor Loeb describes as crises in development will not be likely to take much stock in his conception of the rôle of comparative psychology until experimentation has proved the abrupt appearance of the associative process in the animal series. For until then there will remain the possibility that the whole thing is a matter of degree of ability to profit by experience, rather than of the presence or absence of a brain mechanism which is able to mediate the association. On this point the author says, "The idea of a steady, continuous development is inconsistent with the general physical qualities of protoplasm or colloidal material. The colloidal substances in our protoplasm possess critical points."

Two chapters of great interest treat of the 'Cerebral Hemisphere and Associative Memory' and 'Anatomical and Psychic Localization.' Concerning the valuable experimental data furnished in them we may make only

a general statement. It proves that the associative process in vertebrates is dependent upon the cerebral hemisphere. "The assumption of 'centers of association,'" says the author, "is just as erroneous as the assumption of a center of coordination in the heart. Association is, like coordination, a dynamical effect determined by the conductivity of the protoplasm. Associative processes occur everywhere in the hemispheres (and possibly in other parts of the brain), just as coordination occurs wherever the connection between two protoplasmic pieces is sufficient. It is just as anthropomorphic to invent special centers of association as to invent special centers of coordination."

Finally, attention should be called to the stress which in this valuable contribution to the literature of comparative physiology is laid upon the chemical and physical study of protoplasm and its transformations. Ultimately it would appear all physiological investigations resolve themselves into problems of the physics of colloidal substances.

In this imperfect and inadequate review of Professor Loeb's book an attempt has been made to indicate a few of the general tendencies and conclusions which seem of prime importance. There are a large number of interesting experimental studies discussed in the book which have not even been mentioned here. We have taken the liberty to quote freely from the text, and it is hoped that the sentences thus selected to indicate the author's point of view will in no case misrepresent him because of their isolation.

ROBERT MEARNS YERKES.
CAMBRIDGE, MASS.

Plant Life of Alabama. An account of the distribution, modes of association and adaptations of the flora of Alabama, together with a systematic catalogue of the plants growing in the State. By CHARLES MOHR, Ph.D. Contributions from the U. S. National Herbarium. VI. Washington. 1901. 8vo. Pp. 921. 12 plates and 1 map.

The 'Plant Life of Alabama' is a noteworthy addition to the list of works which treat of State floras. The book consists of two parts; one, of 127 pages, dealing chiefly with the floristics of the vegetation, the other, of 708 pages, containing a complete catalogue of the flora. The first part will be particularly welcomed by phytogeographers as the first serious analysis of a portion of the vegetative covering of the southeastern United States. The value of this portion lies chiefly in the observations and lists which it contains, as no systematic investigation of the vegetation has yet been made. The absence of recent methods and the lack of detailed formational analysis detract much from this part, though the lapse of time between the completion of the manuscript and its publication would seem to indicate that this is not the fault of the author. It is much to be regretted that the author's death occurred before his book finally appeared.

The author sketches the history of the botanical exploration of Alabama, giving a brief account of the labors of Bartram, Peters, Buckley and others. This is followed by a summary of the general physiographical and climatic features of the State. Physiographically, the area considered falls into five regions, the coastal plain, the region of crystalline rocks, the region of the coal measures, the Coosa Valley and the Tennessee Valley. The author gives a brief discussion of the general principles underlying plant distribution, in which he has unfortunately made use of Merriam's divisions of the North American continent, which are phytogeographically incorrect. The formational treatment is based upon the work of Willkomm and Warming. The accurate classification of formations, however, as hydrophytic, mesophytic or xerophytic, is hardly to be determined otherwise than by actual physiometric investigation of formations, which have been tentatively determined by means of floristic. The formational analysis of the vegetation is neither close nor thorough, consisting for the most part of floristic lists of the various habitats, with very slight consideration of the interrelations of the species which constitute the formation. In some instances (page 65) the difficulty seems to rise from the fact that the acquaintance with the particular vegetation is at second hand.

Under biological and ecological relations, the author treats briefly of the forest flora, in which are included shrubby-plant associations and arboreal-plant associations, evergreen and deciduous, the campestrian flora, the water and swamp flora, including the hydrocharidean, lithophytic, limnæan and palustrian classes, and of the organotopic flora, comprising epiphytic, saprophytic, symbiotic and parasitic plant associations. This is followed by an interesting discussion of introduced plants, which are regarded as naturalized, adventive and fugitive. The more detailed consideration of the vegetation is taken up under plant distribution, in connection with the Carolinian and Louisianian areas. In delimiting the two the author makes use of 'truly zonal plants,' which, except in restricted formations, usually of hypdrophytic stamp, are illusive. The Carolinian area falls into the mountain region, the table-lands, the region of the Tennessee Valley and the lower hill country. Under each is given a summary of the physiographical features and climate, and a discussion of the various formations, grouped as xerophile and mesophile forests, and xerophile, mesophile and hydrophytic plant associations. The Louisianian area is likewise divided into several regions, central pine belt, central prairie, maritime pine and coast plain, in which the treatment of the formations is similar.

Notwithstanding the valuable information now made available for the first time in the part just considered, the second part is a more important contribution. It contains an excellent catalogue of the entire flora, in which are enumerated more than 4,500 plants, of which 2,500 are flowering plants and upward of 2,000 cryptogams, numbers which indicate an extreme richness and diversity of vegetation. The large list of fungi, which is contributed by Professor Earle, is a testimony of the energy and industry of a few workers, notably Peters, Atkinson, Underwood and Earle. The algæ are apparently little known as yet, a fact which explains the preponderance of anthropytes in the list. The entries of the flowering plants are models of floristic cataloguing. The bibliography is full, and indications of range, both State and continental, are given with unusual care. The type locality is indicated wherever known, as is also the disposition of the Alabama exsiccati. Altogether the catalogue is the most complete and painstaking State list so far contributed to American botany. The book closes with a list of the plants cultivated in Alabama, a tabular statement of the plants of the State, and a very satisfactory index.

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TWO PAPERS ON ANIMAL MECHANICS.

Ueber die Bewegungen in den Handgelenken, von Rudolf Fick; *Ueber die Bewegungen des Fusses u. s. w.,* von Otto Fischer; both in the 26th volume of the Abhandlungen der Math. phys. Classe der König. Sächsischen Gesellschaft der Wissen., Leipzig, 1901.

These papers are alike, but in some respects quite different. In the former Fick discusses the movements of the bones of the wrist as shown by the X-rays, and though mathematics are not avoided, they are rather subordinate to the results of observation. Thus anyone who is sufficiently at home in the anatomy of the hand can follow the author provided only he take pains enough. Fischer's paper is the fourth part of his 'Gang des Menschen' in which the share of the foot in the walk is scientifically and mathematically studied. This puts it beyond the reach of most readers. Without pretending to be able to appreciate it, we think we run little risk, from the reputation of the author, in recommending it to students of this field.

The paper on the wrist is one that, while very valuable, is not of very general interest to readers other than anatomists. Since the introduction of the X-ray, hands, as convenient objects, have been photographed everywhere, and several anatomists have given attention to the movements of the bones. So far as the results obtained from the dead body go, we are not inclined to modify the opinion which we have expressed, namely, that the X-rays have done little more than confirm what was already known of the movements of the wrist. (This must however be understood

with the proviso that more was known than was found in most anatomical text-books.) But in these studies the living hand has been used, and although our contention still in the main holds good, it is to be admitted that *à priori* we really did not know how closely the movements made on a dead body reproduced the conditions which were the result of motions from within. The work has been very thorough, much attention being given to individual bones. Some of the views strike us as quite original. Thus we do not remember to have seen, in any of the monographs on this subject the position of the carpal bones in palmar and dorsal flexion shown directly from either the front or the back as in the usual view of the wrist. The objection which naturally presents itself, when such a course is proposed, is that the foreshortening of the flexed bones and the hiding of more or less of one row under the other would make the figure worthless, but this objection has by skill in technique been well met. The illustrations are admirable, and are made still more practical by being almost always accompanied by an outline drawing.

The results in the main are these: In lateral motions of the hand we may accept the theory of two oblique axes crossing each other at about the middle of the wrist with the proximal and distal angles larger than the lateral ones; but in flexion and extension we must assume a single transverse axis. A point emphasized is that the mid-carpal joint is a very important one. This is not new to anatomists, but we doubt if it is very familiar to the average student of anatomy. The work in short is both an interesting and a valuable one.

THOMAS DWIGHT.

The Teaching of Mathematics in the Higher Schools of Prussia. By J. W. A. YOUNG, Ph.D., Assistant Professor in the University of Chicago. New York, Longmans, Green & Co. 1900. Pp. xiv+141.

The feeling that German schools have something well worth the American teacher's attention is not at all new. It has been said and written for a century, and within a few years it has given rise to the publication of several works of genuine merit, not to speak of numerous books and articles of no merit whatever. Of the former class this one by Professor Young is unique in that it is the first to devote itself entirely to the mathematical phase of education. Furthermore, it is somewhat unique in being a well-balanced, practical book for practical and well-balanced teachers. It tells one what one wishes to know. Not many Americans have been able critically to examine the subject of mathematics in Prussia. Here is a book that answers just the questions the intelligent teacher would ask if he were there, that gives him courage to face the issues of the present, and that should make him confident of the future. And it does all this, not by preaching American or German supremacy, but by intelligently pointing out the superior features of German education and by showing us our lines for improvement.

The real interest in the book is not so much in the carefully selected general information, for this it is not difficult to find in standard works like those of Baumeister and Russell, but in the consideration of the two questions: Are the Prussian schools doing better work in mathematics than the American? If so, how is this accomplished?

When we consider that we give about ten per cent. more time to mathematics than they do, that they recognize less home study than we, and that their children leave even the classical gymnasium knowing more of mathematics than do our high-school graduates in scientific courses, there can be only one answer to the first question.

The reasons for this state of facts are, briefly, the following: (1) The teachers in the gymnasia are men, and they enter the profession as a life work. (2) These men are university graduates, with at least two additional years of professional training. They have been rigidly examined, not by school teachers whose political pulls have given them place, but by university professors, specialists in their various subjects, appointed by the state. And in addition to all this, they have had at least one year of probationary teaching. Their examinations for the elementary classes include the calculus, and those for the high school grades

require independence of thought in the higher geometry, in analysis, and in analytic mechanics, with a good knowledge of the literature of these subjects. (3) The teacher's position is one of honor, recognized in cases of superior excellence by the title of 'Professor,' bestowed by the government, a title with us 'defamed by every charlatan and soiled by much ignoble use.' (4) The teacher has fewer classes per week than the American teacher, and when out of class instead of being set to watch a 'study hall' he has time for recreation and study. (5) Considering the purchasing power of the money, the teacher comes, after a reasonable time, to receive a somewhat better salary than is offered in America, and hence a relatively stronger set of men enter the profession. (6) His countrymen appreciate that the teacher "can do his best only in an atmosphere of financial and mental tranquility. He must himself be continually growing, and if he is embarrassed by financial cares and harrassed by struggles to improve his material position, his growth is retarded and the quality of his work inevitably deteriorates." He is, therefore, accountable to no local authorities; political 'pulls' have no meaning to him; his superiors in law are his educational superiors as well. He works with the assurance that a pension awaits him when the 'rainy day' comes, and yet he is urged to progress by such manifold inducements that he does not stagnate. (7) The school year is longer than in America, the twenty-minute class periods of our lower grades are unknown, and hence the instruction means more when it is being given and is more consecutive than with us. (8) The teacher teaches; he does not merely hear a recitation. Text-books mean little; home study is not a serious matter; but the class period is a time for serious study, rapid work, heuristic teaching and general inspiration. Space does not permit of speaking of other reasons, or of the results of the system as shown by examination tests.

Professor Young does not, however, claim that Germany is all good and America all bad. Neither does he claim that we can adopt their system. He is eminently judicial in his conclusions, pointing out what we can safely use, and where we can unquestionably improve. On the whole, the book is one of the best balanced works on German education that have appeared, and as such is recommended to every American teacher of mathematics.

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SCIENTIFIC JOURNALS AND ARTICLES.

The *Botanical Gazette* for November contains the following leading articles: G. T. Moore has published with three plates his second paper entitled 'New or Little-Known Unicellular Algæ,' giving a detailed account of the life history of *Eremosphæra viridis,* and coming to the conclusion that for the present, at least, the genus should be classed with the Protococcoideæ; and also describing as a new genus a form which has been confused heretofore with *Eremosphæra,* and naming it *Excentrosphæra.* T. C. Frye has published with one plate an account of the development of the pollen in certain Asclepiadaceæ, his investigation having been suggested by the record that in certain members of this family there is no tetrad division. The development of the sporangium was found to be of the general type, the primary sporogenous cells passing over directly into pollen mother cells; these latter divide in the usual tetrad manner, but subsequently through mutual adjustment the four spores are arranged in a linear series. Miss F. Grace Smith has published the results of a large number of observations upon the distribution of red color in vegetative parts in the New England flora. A general conclusion is reached that the statistical observations obtained fit no one theory of color in all particulars. Mr. George A. Shull has published with illustrations the results of observations upon 'Some Plant Abnormalities.' He records instances of fasciation in *Erigeron Canadense* and *Echium vulgare;* abnormal foliage leaves in *Pelargonium* and *Hicoria;* and abnormal floral organs in *Lathyrus odoratus,* as well as in certain species of *Clematis.* Under the head of 'Briefer Articles,' E. B. Copeland has discussed Meissner's paper on evergreen needles, answering certain

criticisms of the author, and presenting new observations; M. L. Fernald publishes a final paper upon the instability of the Rochester nomenclature, being an answer to papers of Messrs. C. L. Polard, L. M. Underwood and N. L. Britton; and Charles Robertson has published a third set of observations of flower visits of oligotropic bees.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES. SECTION OF GEOLOGY AND MINERALOGY.

THE regular meeting of the Geological Section of the New York Academy of Sciences was held on Monday evening, November 18, with the chairman, Dr. A. A. Julien, presiding. The program of the evening was begun with the reading of a memorial of Dr. Theodore G. White by Professor James F. Kemp, who said in part:

Theodore Greely White was born in New York, August 6, 1872, and was the only child of his parents, both of whom he lost but a short time before his own death. He was graduated from the School of Mines of Columbia University in the course in geology and paleontology as Ph.B. in 1894, as M.A. in 1895 and as Ph.D. in 1898. He was appointed assistant in the department of physics in 1896 and held the position until 1900, being especially in charge of the experimental work in optics. From early boyhood Dr. White was interested in natural science, and while yet an undergraduate he began investigations both geological and botanical. His bachelor's thesis was a description of the geology of Essex and Willsboro towns on Lake Champlain, and he took up the study of the faunas of the Trenton group in the Champlain valley for his doctorate. In the end he extended these faunal studies all around the Adirondack crystalline area. He also carried on work for the New York State Museum under the direction of Dr. F. J. H. Merrill; and, in association with Professor W. O. Crosby, he described the petrographical characters of the Quincy granite. During an excursion to the seashore last summer he became exhausted while bathing in the salt water, and took a cold which developed into pneumonia and caused his death on the 7th of August, after a brief illness. Dr. White was a man of indefatigable industry and of great perseverance. He has left a large circle of sincere and devoted friends who can with difficulty reconcile themselves to his loss.

The second paper was a memorial of Professor Joseph Le Conte by Professor John J. Stevenson. A memorial of Professor Le Conte having appeared in the columns of SCIENCE, an abstract of this paper will not be given here.

The next paper was by Dr. Edmund O. Hovey and was entitled 'Notes on the Triassic and Jurassic beds of the Black Hills of South Dakota and Wyoming.' In this paper the author described, with the aid of a map and a number of lantern slides, the geological characteristics, the stratigraphic relations and the topographic features of the famous Red Valley of the Hills and its inclosing rim of Jurassic shales and sandstones; the observations being, for the most part, a result of a collecting trip made for the American Museum of Natural History during the past summer.

The closing paper was by Dr. Alexis A. Julien and was a discussion of 'Erosion by Flying Sand on the Beaches of Cape Cod.' The author said in part: The physical characters of the beach sand of Cape Cod show, in general, its recent derivation from the adjacent beds of the later Tertiary and especially from sands and gravels of Glacial age. In form the sand grains are mostly angular to subangular with but small admixture of those nearly spherical grains (for which I have proposed the term 'palæospheres') the form of which would indicate long erosion and high antiquity. In constitution the sands differ somewhat from those of the Atlantic coast to the southward, *e. g.*, of Long Island and New Jersey, particularly in a smaller content of iron-oxides and garnet. Through the continual movement of the winds over the peninsula, the sand upon the beaches and dunes is in a state of constant motion. During the frequent winter storms it is even borne along in vast quantities by aërial transport, and commonly with a violence sufficient to produce sharp attrition upon fixed solid objects.

The distribution of the sand is carried on from two directions: from the west along the south shore and from the north along the east and west sides of the 'forearm' of the Cape. The result is that the elbow tends to extend farther into the ocean, and Massachusetts Bay is a pocket steadily filling up with sand from the north. With the great fall of the tide on that coast, however, broad shoals are daily offered to sun and wind and the dried sands are constantly blown up on the highest dunes of the Cape, viz., those near Barnstable. There are ancient dunes along the coast, sometimes farther inland and even covered by forests, whose aggregation may be attributed to special violence of wind action at a remote period.

The most prominent results of the erosive action of the wind-driven sand are those pertaining to the general sculpture of headlands and summits of dunes, and the eating away of the softer layers of gravel and sand of which the bluffs along the east coast consist. The fine example of such erosion at Truro was described in detail and illustrated by means of a photograph. The recession of the face of the bluff here and everywhere from a vertical plane clearly indicates that its principal erosion is being constantly carried on by aërial rather than by marine attack. On the Cape, as elsewhere along our Atlantic coast, it is a common error to attribute the ravages on bluffs and dunes, noticed after a severe storm, too much to the incursions of the sea. A very large part of the damage has been done by the violence of the wind, reinforced by vast quantities of sand and spray lifted up and hurled continuously for hours against all opposing objects.

Other effects of the natural sand blast are shown in the pitted surfaces of small bodies strewn upon the beach, in the projecting hard minerals of the beach pebbles and in the depolishing of exposed portions of bits of glass and pottery. 'Faceted pebbles' are lacking from the beaches, because there is too much motion to permit of grinding anything to a flat surface. The rapidity of the eroding action under favorable circumstances is surprising. During the great gale of November 25, 1899, one night sufficed to convert into ground-glass the window panes in the exposed sides of the life-saving station at Truro. No scratches or grooves appear in these surfaces, such as have been observed in the sand-fretted pebbles of a desert, the conditions of sand erosion on a beach tending to pit the surface rather than to produce striæ.

The least obvious, but perhaps the most important, effect of this form of erosion is upon the flying sand grains themselves by mutual attrition, minute particles not being protected from wear as they are when suspended in water. By the splitting of particles from the grains and their own final reduction to the most minute size, the production of silt is constantly in progress upon these windy beaches, and it is regularly carried away in suspension by every tide.

The papers of the evening were discussed by Professors J. J. Stevenson and R. E. Dodge and Dr. A. W. Grabau.

In response to an invitation from the chair Dr. W. S. Yeates, State geologist of Georgia, gave some account of the history of the geological survey of that State and a brief statement about the work being carried on by the present organization. Appreciative comments were made by Professors J. F. Kemp and J. J. Stevenson and Mr. G. F. Kunz.

Edmund O. Hovey,
Secretary.

RESEARCH CLUB OF THE UNIVERSITY OF MICHIGAN.

At a meeting of the Research Club of the University of Michigan, held November 7, 1901, the evening was taken up with the presentation of papers by Professors Rolfe and Novy.

Professor Rolfe spoke on 'The Use of Ellipsis in the Explanation of Grammatical Phenomena.'

Dr. Novy gave an account of the investigations which Dr. Freer and he had carried on during the past year. After reviewing the work hitherto done concerning the action of metals, such as gold and copper, upon bacteria, it was pointed out that the explanation of this

action as offered by Behring was insufficient, and that there was good reason for believing that such metals exerted a surface action resulting in the formation of peroxides which clearly possessed a greater germicidal action than hydrogen peroxide. The action of light upon bacteria, especially of sunlight, was discussed, and although the studies of Richardson, Dieudonné and others rendered it certain that hydrogen peroxide was formed under these conditions, nevertheless it was by no means demonstrated that this substance was the active germicidal agent. These considerations led the authors to the belief that the germicidal effect of metals and of sunlight was due to higher and more active peroxides. Accordingly a number of organic peroxides were prepared and their action on bacteria was studied. Several of these were found to be wholly inert. This was the case with aceton peroxide and dibenzoyl peroxide. On the other hand, the diacetyl and the benzoyl acetyl peroxides were found to be extremely germicidal. It was pointed out, however, that these bodies were not germicidal as such, but that in aqueous solution hydrolysis took place, resulting in the formation of acetyl hydrogen peroxide and benzoyl hydrogen peroxide respectively. The intense germicidal as well as oxidizing power of such solutions was therefore due to the products of hydrolysis.

It was pointed out that these last mentioned peroxides were capable of destroying the most resistant spores usually inside of a minute. A comparison with hydrogen peroxide showed that this substance was much more feeble in its action. In order to obtain approximately the same germicidal effects it was necessary to prepare solutions of hydrogen peroxide which contained eighty times as much active oxygen as that contained in a solution of benzoyl hydrogen peroxide. This fact was interpreted as showing that the organic peroxides exerted their germicidal action not through nascent oxygen, as is commonly held in the case of ozone and hydrogen peroxide, but rather through other means, possibly through ions. In the subsequent discussion it was pointed out that other interpretations were possible; that the oxygen liberated might possess a higher potential energy than that from hydrogen peroxide; or that the organic peroxides might be dissociated, as in the case of alcohol, not so much into ions as into one or more active parts.

Dr. Novy also detailed at some length the investigation bearing upon the relation of the surface action of metals to the formation of benzoyl acetyl peroxide. Metals, paper and fabrics, as well as sand, originally employed by Erlenmeyer and by Nef, exert a marked favoring action which may be interpreted as due to occlusion and partial dissociation of oxygen.

FREDERICK C. NEWCOMBE,
Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

AT the meeting of the Academy of Science of St. Louis on the evening of December 2, 1901, the following subjects were presented:

Mr. J. Arthur Harris presented in abstract a paper on 'Normal and Teratological Thorns of *Gleditschia triacanthos* L.'

Professor A. S. Chessin, of Washington University, delivered an address on 'The harmony of Tone and Color.' The speaker said that although the idea is not new that colors, like tones, are subject to laws of harmony, he did not know that any systematic theory concerning this had thus far been presented, and the object of the paper was to establish such a theory. A color-scale was constructed and the properties of the intervals corresponding to those appearing in the musical scale were discussed, and the conclusion was reached that within the limit of an octave the laws of harmony in tone and color are identical.

A paper by Professor A. S. Chessin, on 'The true Potential of the Force of Gravity,' was presented and read by title, the author remarking that this was the first of a series of detailed papers bearing upon the general subject, the broad conclusions concerning which he had presented in synopsis at a recent meeting of the Academy.

A committee was elected to nominate officers for the year 1902.

WILLIAM TRELEASE,
Recording Secretary.

SHORTER ARTICLES.

THE SMALLEST KNOWN VERTEBRATE.

The United States has borne the distinction of having, in certain cyprinodont fishes of the Southern States, the smallest known fishes and at the same time the smallest known vertebrates. Thus, *Heterandria formosa* Agassiz, found from South Carolina to Florida, has an average length of 25 mm. for females and 18 to 19 mm. for males. *Lucania ommata* (Jordan), recorded only from Florida, probably never exceeds an inch in length; two males, the only ones thus far found,* measured 19.5 and 20 mm., and two females from the same locality were 20 and 22 mm. long, exclusive of caudal fin. Of this species Dr. O. P. Hay† remarked that 'it may contend with *Heterandria formosa* for the honor of being the smallest known vertebrate.' Another diminutive member of the cyprinodontids is the well-known viviparous *Gambusia affinis,* the adult males of which sometimes barely exceed 12.5 mm. in length, although the females reach a length of 50 mm. In this family are several other species that are scarcely larger than those before mentioned. The pigmy percoidean, *Elassoma evergladei* Jordan, of the swamps of Georgia and Florida, ranges from less than 20 mm. to a maximum of about 33 mm. in standard length, and several of the darters are no longer. Among the marine fishes, there are a number of gobies whose length is barely 25 mm. The smallest of the known marine vertebrates, however, is probably the lancelet, *Acymmetron lucayanum* Andrews, from the Bahamas; examples taken by the *Fish Hawk* in Porto Rico are about 19 mm. long, although Dr. Andrews' types in the National Museum are nearly a third smaller.

The United States Fish Commission has recently received from the Philippine Islands numerous specimens of a species of fish now to be described which has a maximum size less than the minimum adult size of most of the foregoing species, while the minimum and average sizes for mature individuals are thought to be less than those of any other known fish or other vertebrate. The specimens were obtained, through the courtesy of the Surgeon-General of the army, by medical officers connected with the military hospital at Buhi, southern Luzon, in the department of Camarines Sur; and were collected in Lake Buhi, to which the species is said to be peculiar.

The fish is a member of the great cosmopolitan goby family, of which upwards of 600 species are known; and exhibits peculiar characters which necessitate the creation of a new genus for its reception. The diagnostic features of this genus, for which the name *Mistichthys* (μεῖστος, the smallest) is proposed, are coalescent ventral fins not adnate to the abdomen, two well-separated dorsal fins of which the anterior contains three weak spines, a single series of conical teeth in each jaw, body covered with large ctenoid scales, and an elongated genital papilla by the shape of which the sexes may readily be distinguished.

This species, to which the name *Mistichthys luzonensis* is given, and which will be more fully described in a forthcoming paper in the Fish Commission Bulletin, is apparently nearly transparent in life, with a black chin, a black median line behind the anal fin, and a few black spots on the back. It is probably viviparous or ovo-viviparous; but while many of the specimens contain ripe ovarian eggs (some of which have been discharged in the preserving medium), no eggs exhibiting evidences of development have been found. The females are slightly larger than the males and average 13.5 mm. in length; the maximum for egg-bearing fish is 15 mm. and the minimum less than 12 mm. The average length of males is about 12.5 mm., the maximum is 13.5 mm., and the minimum is under 10 mm. The average length of 50 specimens taken at random, both sexes about equally represented, was 12.9 mm.

A fact of more than ordinary interest in connection with this diminutive species is that it is a food-fish of considerable importance. Dr. George A. Zeller, acting assistant surgeon U. S. A., writing from the military hospital at Buhi, says:

"I enclose herewith samples of a strange

* Woolman, *Bulletin U. S. Fish Comm.*, 1890.

† *Proc. U. S. Nat. Mus.*, 1885.

article of diet greatly relished by the Bicols, among whom I have been stationed for the past eighteen months. Rice and fish are the staple articles of diet for most Filipinos and in the provinces of the Camarines there is little variation from these two. Fishes of every size and many varieties are prepared in every conceivable form, but the samples enclosed are unique in that they are found here and nowhere else. * * * Many varieties of fish abound in the lake, but by far the most numerous are these minute specimens. They are called in the native Bicol tongue *sinarapan,* and when dried in the sun on a leaf are called *badi.* They are caught by a large sheet of close web, which is dipped under wherever a school congregates. They are put into tightly woven baskets from which the water soon drains, leaving a compact mass of fish. They are not minnows or immature fish. They are adults and attain no greater size. The natives buy them eagerly; and when the little fleet of fishermen return from their morning's quest and place their baskets upon the ground on the market place, they are instantly surrounded by a crowd of waiting children who, armed with every sort of dish, are anxious to take home the family meal. They bring three or four potato tubers, a handful or two of rice, or a few copper pennies, and in exchange receive about a pint of fish. In the kitchen the fish are made up with peppers or other spiced herbs, and they do not taste bad. The soldiers have become quite fond of this food, and liberally patronize the little native restaurants where it is served."

H. M. SMITH.

WASHINGTON, D. C.

DINOSAURS IN THE FT. PIERRE SHALES AND UNDERLYING BEDS IN MONTANA.

IN the summer of 1900 I made a collection of Dinosaur and Mosasaur remains from the Ft. Pierre beds, near Fish Creek, in Sweetgrass County, in Montana. I have not noticed any account of the collecting of Dinosaurs from this horizon.

The beds are composed of dark-colored shales, with occasional very thin lenses or layers of sand. Sometimes the shales have no grit, sometimes they contain much fine sand. There are many brown or grayish, rounded concretions or concretionary layers. These concretions are often very hard. In these are many of the fossils, both vertebrate and invertebrate. The mollusca are principally the well-known, characteristic Ft. Pierre forms such as Ammonites, Baculites, Scaphites, Nautali and many smaller forms.

In this locality the weathered surface of the beds forms a rolling, grass-clad prairie with occasional ravines cutting into the soft shales. The bones are sometimes found in these ravines and 'cut banks' and sometimes among the grass roots, some of the bones projecting above the short grass.

The harder sandstones in the formation above form a line of bluffs or 'rim-rock' which for many miles marks the southern boundary of the Ft. Pierre shales. There are also dark shales interbedded with these sandstones. This formation contains leaf impressions and many fragments of Dinosaur bones, but the fossils have not been studied and no characteristic ones were recognized.

Below the Ft. Pierre shales are hard, rather thin-bedded sandstones with interbedded shales. Still lower are hard and soft sandstones, the latter predominating. These contain plant impressions, fossil wood, a few apparently fresh-water or brackish-water shells and Turtle and Dinosaur bones. The latter, many of them, were in a beautiful state of preservation, but no nearly complete skeletons were found. In these beds are bands of peculiar black or very dark, hard nodules, that look something like basalt. These sometimes contain bones. The Dinosaur remains are of the *Claosaurus* type.

From the Ft. Pierre beds the greater part of the skeleton of one Dinosaur and a good number of bones of another were obtained, besides he skull and other parts of Mosasaurs. The more complete Dinosaur skeleton is in the museum of the University of Montana. It undoubtedly is a *Claosaurus.* The other portion of a skeleton is in my collection. It is much smaller and was undoubtedly quadrupedal in gait. The sacrum is nearly complete and is different from anything else that I have seen.

It is composed of three ankylosed vertebræ.

It is interesting to find Dinosaurs in these marine beds. The marine fossils are found mixed with the bones. While digging out the skeleton of *Claosaurus* nearly a dozen *Nautali* were found among the bones. As a rule, when bones are found a good part of the skeleton is there or there is evidence that it has been. Several skeletons had been found and the bones removed for curiosities before I had visited this region. The first skeleton I saw was shown to me by a young man, Mr. Albert Silberling, who lived on the ranch from which the others were dug. I think that very few fossil-hunters would have looked for Dinosaur bones here.

It seems that these deposits were made in a shallow inland sea or an estuary which, at least during a part of the time, was cut off from the ocean, for in places there is considerable gypsum. Perhaps we should hardly expect to find such large marine mollusca in such a place, but they evidently are not far from where they died. There is no evidence of strong tides, and if the shells had been washed up by these or the winds they would be broken, not complete as we find them.

As a rule land animals are not very perfectly preserved in marine deposits. In unearthing these animals, therefore, the question is always arising: "How did these bones get here?" Did these Dinosaurs that have been so modified, evidently fitting them for life on land, still retain their swimming habits, but occasionally suffer shipwreck and their carcasses sink to the bottom of the sea? By some invasion of the sea were they forced to stay and starve or 'swim for life' which proved in some cases to be for death? I have seen no indications that they were killed by violence or their carcasses destroyed by large carnivorous animals, though there has been a little disturbance of the bones. Did they die on some mud flat or did their carcasses float down some sluggish stream and get stranded in shallow water or get 'water-logged' and sink in deeper water? These are interesting questions, but more thorough and careful investigation is needed to decide the matter with any degree of certainty.

The University of Montana hopes before very long to publish a bulletin describing these beds and whatever is of interest in the collections obtained from them.

Earl Douglass.

Princeton, N. J.

Magmatic Differentiation of Rocks.

Since the time when the celebrated chemist Bunsen first elaborated his theory on the nature of rock magmas, the subject has been of great importance to the geologist. If one were asked to name three of the grander ideas which mark the progress of geology during the century just closed, this conception of magmatic differentiation of rocks would certainly be one of them. Of late years contributions to the subject have been numerous and important. Several of the most recent are especially noteworthy.

In the reconsideration, by H. S. Washington (*Bulletin Geological Society of America*, Volume XI.), of the 'Igneous Complex of Magnet Cove, Arkansas,' made exceptionally interesting through the elaborate efforts of J. Francis Williams, are recorded some observations on magmatic differentiation that are of unusual significance at this time. Contrary to previously expressed opinion, the several types of deep-seated rocks represented in the complex are regarded as integral parts of one great mass and as contemporaneous in origin, and therefore not due to successive intrusions. Furthermore, the structure of the whole mass is probably laccolithic in character.

A remarkable feature connected with the zonal distribution of the various rock-types is the complete reversal of the order almost invariably found among large masses of cooled magmas. Ordinarily the borders are basic and the central parts more acidic. But in the Magnet Cove mass the heavy constituents are in the center and the lighter silica, alumina and alkali components are on the edges. Notable instances of similar character are reported from Norway, Finland and Montana.

The exceptional character of the Magnet Cove mass appears to suggest unusual conditions. While the general subject of the causes of differentiation is not discussed at length, a possible explanation for the Arkansas complex

is offered. Briefly stated, the essential idea is that, just as in a highly cooled vessel of salt water the ice crystallizes at the sides, bottom and top, leaving a core of more concentrated liquid at the center, so here the solvent may have frozen out, collecting at the borders of the cavity in a more or less pure condition, as foyaite, and gradually becoming more basic (richer in the solute) as the freezing process crept towards the center.

Although the great work of the Russian petrographer, F. Loewinson-Lessing, on the Eruptive Rocks of the Central Caucausus, was issued more than two years ago, the views advanced are only beginning to get into form accessible to the majority of English students. The general interest lies in the discussions of the subjects of rock-classification and the differentiation of rock magmas.

The classification proposed for the igneous rocks is chemical. It is based primarily upon the degree of acidity of the silicate minerals. Four great groups are thus established: (1) The ultra-basic rocks, derived from a monosilicate magma, (2) basic rocks, which had a bisilicate magma, (3) neutral rocks, with a magma which was bisilicate or normal, and (4) acid rocks, in which the magma was polysilicate. These groups are subdivided in 14 sub-groups and 34 families.

In order to find the proper systematic position of an eruptive rock from the fundamental viewpoint of the proposed classification four factors are considered: (1) The relation of the oxygen in the silica and that in all the other oxides taken together, giving what is termed the coefficient of acidity; (2) the chemical composition, which gives for each type a distinctive formula; (3) the relations between the two groups of oxides according to their molecular proportions; and (4) the relations of the soda and potash in the alkaline rocks. This consideration of the principles of classification leads to the proof of the distinct phases of fundamental magmas.

Discussion of the differentiation of rock magmas has an unusual interest. The Russian author calls special attention to the principle of Soret, the action of super-saturated solutions, the effect of gravity, the principles of maximum work as proposed by Berthelot, and the reaction of mixed liquids, as operating in the separation of magmas.

Three distinct kinds of magmatic differentiation are recognized. They are: Static differentiation, taking place in the depths of the earth; differentiation by cooling during ascent to the surface; and crystalline differentiation. Specific gravity, pressure and temperature are the chief factors governing the course of the static kind; while chemical affinities come into play in large measure only in crystalline separation.

The rôle of inclusions of foreign rocks, which has so long been such an unsatisfactory subject to petrographers, is explained on the idea that it is only that portion of the magma yet undifferentiated which affects the introduced rocks. After thorough assimilation of limestone, for example, a separation of the modified magma takes place. One part contains very little lime and the other nearly all of it. Rock formed from the first mentioned might be a granite, while from the second would come perhaps a gabbro.

CHARLES R. KEYES.

ON THE REASON FOR THE RETENTION OF SALTS NEAR THE SURFACE OF SOILS.

VERY recently a light-colored saline incrustation was noticed by Professor Milton Whitney upon the surface of the soil in the grounds of the Department of Agriculture in Washington. This crust was collected and examined in the laboratory of the Bureau of the Soils under the direction of Dr. Frank K. Cameron. The crust contained about 1 per cent. of soluble matter, principally sulphates and nitrates of sodium and calcium. Samples were then collected at different depths and examined to determine the vertical distribution of the soluble salts. The results showed that although the soil was examined to a depth of three feet, practically all of the salt was in the surface inch, the larger part of it being in the top eighth-inch.

The crust was found at the end of a short, dry season, such as is common in the autumn months along the Atlantic coast region.

A number of similar occurrences of abnormal amounts of soluble matter on the sur-

face of the soils of humid regions have been reported, but very little has been written about them. Cameron has, in Bulletin No. 17, Division of Soils, described a number of occurrences of crusts in humid regions, and has called my attention to several others which were not known to him at the time his paper was published. All of these cases were after a short season of dry weather, but it must be admitted that their occurrence seems rather an anomaly when the heavy rainfall is considered. For what is the reason that this salt remains near the surface of the ground when the water from the rains passes down through the soil? If the salt which is soluble in water is dissolved by the downward percolating rains, why is it not continually washed deeper into the subsoil? Why is it that, in spite of the fact that more water passes downward than returns to the surface by evaporation and capillary movements upward, analyses of soils in the humid regions invariably show more soluble matter in the surface soil than in the subsoil?

There are several reasons which may account for this seemingly anomalous condition of affairs. First, in the soils of the humid region the great bulk of the decomposition of the soil minerals and the consequent liberation of soluble matter takes place within the soil proper in which the greatest aeration takes place, where the bacteria are most numerous and where tillage and sunlight and changes of temperature have a maximum influence.

A second reason which might be given is that of absorption. Very little definitely is known about the phenomenon called absorption, beyond the fact that it is a property of soil grains or of any surface by virtue of which matters in solution are held so that is difficult to wash them off, so that salts which are liberated during the processes of weathering are held near the surface by the absorption.

There is a third factor which seems to assist in accounting for the salts at the surface, and that is that there is a difference between the rates of downward and upward movements of salts within the soil.

When water falls on the soil both gravity and capillary attraction act in the downward movement. Capillary attraction is more effective in the smaller spaces between the soil grains, while gravity is more effective in the larger openings. When water leaches through a soil in a field, by far the larger part of it passes through the larger openings—those produced by insects, worm burrows, root holes, cracks, large interstitial spaces formed by coarse grains, etc. That such is the case is very easily proven if the rate of percolation is measured through a block of soil in field condition, and the same block is broken up dry, so as to prevent puddling and the rate of percolation is measured again. A simple examination of any soil in the field will reveal the presence of these larger openings, and as the resistance to flow varies as the fourth power of the diameter of the tube, a much larger amount of water passes downward through the large openings, than passes through the smaller true capillary spaces. These larger openings might well be called the gravitational spaces, and the smaller spaces in the soil grains the capillary spaces.

When water moves upward through a soil to replace that lost by evaporation or removed by plants, the movement is entirely capillary and the entire film around the soil grains moves.

Now let us consider the action which takes place when rain falls upon a soil covered with a thin soluble crust. First of all the soluble matter is dissolved and carried down into the soil. The downward-moving wave penetrates most rapidly along the gravitational spaces, since here the resistance is least and the front of the wave is drawn laterally into the true capillary spaces by surface tension. These capillary spaces, therefore, largely fill with water from the front of the wave, and since the front of the wave contains the greater part of the salt dissolved, this salt is thus retained in the capillary spaces. As soon as the capillary spaces are filled, practically all movement in them ceases, except the slow downward percolation caused by gravity, and in a soil of average texture this movement is practically nothing. The movement in the gravitational spaces continues. The salt in the water which was drawn back from the front of the penetrating wave remains stationary or only

escapes out into the gravitational spaces by diffusion.

When the rain ceases the gravitational spaces drain of water, carrying off relatively a small part of the soluble matter, and the evaporation from the surface causes the upward movement to commence, but this movement is entirely capillary and the whole film around the soil grains moves, and as it moves so does all of the salt except possibly that portion absorbed, and there is evidence which leads one to believe that the absorbed salt moves also, but rather more slowly than the film; that is, the absorbed salt shows a tendency to lag behind.

Therefore, it will be seen that the rains do not move the salt as far down as they penetrate but leave the most of it near the surface of the soil or at least so close to the surface that capillary movements will again accumulate at the surface as soon as the dry season occurs.

This explanation of the movement of soluble salts within a soil finds application in a number of ways. In the arid regions, where the soluble salts are more abundant than in the humid climate, and where the movements of these salts, if not understood and controlled, ofttimes result in the accumulation of soluble matter this explanation of the difference in the rate of downward movement, compared with the upward movement, goes far to explain some points which were heretofore but imperfectly understood. For example, it has always been difficult for the writer to understand why alkali salts should continue to accumulate at the surface of the ground in spite of the repeated irrigations, and the maxim laid down by agriculturists in that region that 'alkali goes with the water.' In one district of especial notoriety in California the water table was thirty years ago about sixty feet below the surface of the ground and there were no indications of alkali. Irrigation was commenced and continued large and excessive quantities were used. All of the time the water table was steadily rising, showing unquestionably that more water went downward through the soil than came up for evaporation, and yet in spite of this accumulative downward movement of the water the alkali salts, which, so far as can be gathered from adjacent unirrigated areas, was within the surface twenty feet of the soil, have been steadily creeping upward and at the present time fully ten per cent. of the area is suffering from an excess of alkali salts.

It is plain that if we desire to send the salts downward the easiest way to do it is to make the downward movement, as far as possible, capillary instead of gravitational. One way of doing this is to break up the soil gravitational spaces by deep cultivation and subsequent firming by flooding. Such has been found very effective in certain areas of Arizona. Another way is to flood the soil with frequent shallow irrigations. In this way a slow downward capillary current is kept up. Half a dozen floodings with one inch of water each will be found to carry downward much more salt than one flooding of six inches.

Another lesson taught, one well known for many years, is that if the subsurface water is alkaline it must not be allowed to rise so close to the surface that continuous upward capillary movement is possible; else the alkali will accumulate in the soil, to its detriment.

THOS. H. MEANS.

BUREAU OF SOILS,
WASHINGTON, D. C.

CHEMISTRY IN THE CALIFORNIA SCHOOLS.

THE chemistry teachers of the Pacific coast have organized an association to encourage the teaching of chemistry, to harmonize methods, to become acquainted with each other and with the needs of the country and the conditions affecting their profession; and, generally, for all those purposes for which association is good. The organization was effected last August, during the Summer School session of the University of California, at which many teachers from California and from the neighboring States were present. The headquarters of the organization are at Berkeley, which, as it is the educational center of the western part of the country, is the natural location for such a purpose. Two members of the faculty of the University of California, one in the department of chemistry and one in the department of physics, were among the organizers.

The need for such an organization is shown

by the number of schools in which chemistry is taught. A recently published list shows that there are 116 schools in California whose graduates are admitted by the University of California without entrance examination. Twenty-five of these are not accredited in chemistry, but the remaining ninety-one have chemistry courses sufficiently thorough to satisfy all University requirements. And in the twenty-five not accredited in chemistry the subject is taught in most cases, though not with the necessary thoroughness. Moreover, there are many other schools in the State whose graduates are not accorded free entrance to the University, and the names of which do not, in consequence, appear on the published list, in which chemistry is one of the subjects taught. It is probable that in the State of California alone there are at least one hundred and fifty chemistry teachers; and it would be making a very modest estimate and one undoubtedly far below the true numbers to estimate at two hundred the chemistry teachers who look toward Berkeley for their inspiration.

As yet the new organization is in a formative condition. It has been getting itself together, rather than attempting to accomplish anything. Its first circular of information, just published, contains, however, a number of interesting facts. On data, not as complete as desirable, it was shown that the high-schools of California give their students a year of chemistry, recitations being supplemented with laboratory practice. The majority of the schools report fairly good laboratory facilities, one small school in the southern part of the State claiming to have a better equipment for elementary work than does the University itself. Of books of reference there is an almost total lack. In many cases there are no reference-books whatever.

One of the interesting features of the first circular is a letter from President Ira Remsen of Johns Hopkins on the proper methods of chemistry-teaching. He writes:

I thank you for the opportunity you have given me to say a few words to the members of your association. The formation of such societies as yours will, I am sure, do much to further the study of chemistry and raise the standard of teaching. As I have watched the work of teachers of our science in schools, in colleges and in universities, it has seemed to me that the chief defect is what in plain English may be called slovenliness. The students get into bad habits of work and have no clear idea in regard to what they are doing. They are often left to themselves too much and work as they ought not to, without knowing that anything is wrong. Then, too, when the students attempt to give an account of what they have done, they use language that would hardly be permitted in a recitation room or in writing about a literary or historical subject. The language and the notebooks are apt to be slovenly, especially if the work has been slovenly. Now, we shall never get what we ought to get from laboratory courses in chemistry or any other subject until this slovenliness is eliminated. The ability to state the source of an element, its properties or the law of definite proportions or any other law —this ability is of little value. This kind of knowledge is meaningless unless based upon some actual experience in the laboratory.

Courses in scientific subjects are still on trial, and we teachers of chemistry are to determine by the way we do our work whether these courses are to be recognized as valuable from a purely educational point of view. Too much of the instruction now given seems to be shaped with the idea that the pupils are all to become chemists. As a matter of fact, this is true of very few of them. But I may as well stop here. I have opened up too broad a subject to be dealt with satisfactorily at this sitting.

Edward Booth,
Secretary.

SCIENTIFIC NOTES AND NEWS.

Professor Yves Delage has been elected a member of the Paris Academy of Sciences in the section of zoology, in the place of the late Lacaze-Duthiers.

Mr. Philip Watts, F.R.S., has been appointed director of naval construction by the British Board of Admiralty, succeeding Sir William H. White, F.R.S., who has resigned in consequence of ill health.

Dr. Charles Porter, M.D., of Shrewsbury, has been selected for the appointment of medical officer of health to the municipality of Johannesburg. The salary is £2,000 per annum.

WE learn from the *American Geologist* that Dr. H. M. Ami, of the Geological Survey of Canada, who sustained a rather severe injury to his left arm and shoulder last September, from a fall down a steep cliff at Cap à L'Aigle, below Quebec City, is sufficiently recovered to resume his official duties at Ottawa.

DR. J. W. SPENCER is at present engaged in geological explorations in Central America.

UNDER the auspices of the astronomical department of Columbia University Sir Robert S. Ball will lecture in Havemeyer Hall, on January 10, at 3:30 P. M. His subject will be 'The Cause of an Ice Age.'

DR. SVEN ANDERS HEDIN, the Swedish traveler, who recently reached Ladakh, Cashmere, from exploring the Gobi desert and Thibet, has informed King Oscar that his party was attacked by Thibetans during his journey and that all his collections and almost the whole of his caravan was lost, but that his notes were saved.

DR. ALES HRDLICKA will start about January first on his fourth expedition among the Indians of the southwestern United States and northern Mexico. These expeditions are a part of the system of anthropological exploration and investigation known as the Hyde Expedition and are carried on under the direction of Professor F. W. Putnam for the American Museum of Natural History. The expenses of the present undertaking are generously provided for by Mr. F. E. Hyde, Jr., of New York City. Dr. Hrdlicka is in charge of the somatological work of the Hyde Expedition and his plan, now more than half fulfilled, is, in the main, to ascertain the physical characteristics of the extinct as well as the living peoples in that area which has once been occupied by the Cliff-Dwellers and Pueblos, and by the Toltec, Aztec and Chechemec peoples. It is hoped that on the present journey the somatological part of the research in the field will be completed. The principal tribes that will be studied on the present trip are the Pimas, Papagos, Yaquis, Mayos, Tepehuanes, Coras, Aztecs and Tarascos. Dr. Hrdlicka will be accompanied and assisted by Mr. Gustavus Meyers, of New York City.

THE editors of the *Botanische Centralblatt* for Great Britain are: Algæ, Miss Barton, British Museum (Natural History); Fungi, Mr. Massee, Royal Gardens, Kew; Archegoniatæ, Mr. A. Gepp, British Museum (Natural History); Phanerogams, Mr. Daydon Jackson, 21 Cautley Avenue, Clapham Common, S.W.; Cytology, Professor Farmer, Royal College of Science, S. Kensington; Physiology, Professor Vines, Headington Hill, Oxford; Morphology, Dr. W. H. Lang, University, Glasgow; Paleontology, Professor Scott, Old Palace, Richmond, Surrey.

MR. CLARENCE KING, the eminent geologist, died at Phœnix, Arizona, on December 24. Born in Newport, R. I., he graduated from the Sheffield Scientific School of Yale University in 1852, and joined the California Geological Survey in 1853. He was instrumental in the organization of the U. S. Geological Survey, of which he was director from 1878 to 1881. We hope to give subsequently some account of Mr. King's geological work.

SIR JOSEPH HENRY GILBERT, the well-known agricultural chemist, died on December 23, aged 83 years. With Sir John Bennet-Lawes, he was over fifty years director of the Rothamsted Laboratory, and was for some years professor of rural economy at Oxford University He was a fellow of the Royal Society and a correspondent of the Paris Academy of Sciences.

MAJOR ROBERT TEMPLE, the well-known southern engineer, died at Richmond, Va., on December 22, at the age of seventy years.

Nature records the death of the Rev. Hugh Alexander Macpherson, of Glendale, at the early age of forty-three. Mr. Macpherson was an authority on the fauna of the lake country, and had published an elaborate work on the subject, 'A Vertebrate Fauna of Lakeland, including Cumberland and Westmoreland, with Lancashire North of the Sands.' He was also the author of a book entitled 'British Birds.'

MR. ANDREW CARNEGIE has offered the city of Akron $70,000 for a free public library, the city to guarantee $7,000 annually to maintain it.

The Misses Olivia and Caroline Phelps Stokes have presented to the Board of Managers of the New York Botanical Garden, $3,000, on condition that the interest of this fund should always be used for the investigation and preservation of native plants, or for bringing the need for such preservation before the public. The income this year is offered in three prizes for papers on the subject mentioned. The papers must be presented not later than February 1, 1902.

At a meeting of the trustees of the Connecticut Agricultural College, on December 27, a resolution was passed favoring a bill now before Congress providing for the study of forestry and mining in the agricultural colleges.

An Anthropological Club was recently organized at Yale University. Dr. Kellar presided and Professor Sumner outlined the subjects to be treated. The attendance was eighteen.

The Society of College Gymnasium Directors met at Columbia University on December 27 and 28. The following officers were elected: *President,* Professor Paul C. Phillips, Amherst College; *First Vice-President,* Edward Hitchcock, Jr., Cornell University; *Second Vice-President,* Dr. Frederick E. Parker, Brown University; *Secretary and Treasurer,* Dr. James A. Babbitt, Haverford College; *Executive Committee,* Dr. R. Tait McKenzie, McGill University, Montreal; Dr. Dudley A. Sargent, Harvard, and Dr. William G. Anderson, Yale; *Council and Committee on Admissions,* Dr. Casper W. Miller, University of Pennsylvania; Dr. Watson Lewis Savage, Columbia; Professor A. Alonzo Stagg, University of Chicago, and the officers of the Society, *ex-officio. Committee on Strength Tests and Inspection of Instruments,* Dr. Sargent, Harvard; Dr. Savage, Columbia, and Dr. Jay W. Seaver, Yale. *Committee on Nomenclature,* Dr. Anderson, Yale; Dr. Sargent, Harvard, and Professor George Goldie, Princeton.

The twelfth annual banquet provided for in the will of the late Henry Shaw, the founder of Shaw's Botanical Garden, was given on December 7, at the Mercantile Club, St. Louis.

The *Lancet* states that the fellows and associates of the Institute of Chemistry assembled under Professor J. Millar-Thomson, F.R.S., the president, for their annual dinner on December 4. The president was supported by a distinguished company. The minister of agriculture emphasized the importance of scientific chemistry to agriculture. The president gave a general report on the condition of the institute, pointing to the advance that that body was steadily making in the high standard of its examinations.

The Archeological Institute of America held its annual meeting at Columbia University, on December 27 and 28, under the presidency of Professor John W. White, of Harvard University.

At a meeting held in London on December 5, under the presidency of Dr. W. R. Smith, a medico-legal society was organized.

The *Lancet* states that at the meeting held on November 25, M. Gaule laid before the Paris Academy of Sciences the result of some researches which had been undertaken by himself with a view to ascertain whether the results of a balloon ascent were comparable with those obtained at a high altitude on land—*e. g.,* at the top of a mountain. The most notable of these is a marked augmentation in the number of red corpuscles. Viaux and sundry observers who followed him have ascertained that at a high altitude there is a great increase in the number of red corpuscles. Thus in the Cordilleras at a height of 4,000 meters, Viaux found 8,000,000 red corpuscles per cubic millimeter. M. Gaule wished to see whether in a balloon ascent, where ascension is very rapid and entails no muscular exertion, a similar phenomenon would occur. He made two investigations at heights of 4,200 and 4,700 meters and found in himself 8,000,000 red corpuscles per cubic millimeter. Further, M. Gaule at a height of over 4,000 meters made some blood-films stained after Ehrlich's method with eosin and hæmatoxylin. He found numerous red corpuscles which showed a nucleus colored blue by the hæmatoxylin. This nucleus was in many instances segmenting, and also groups of three or four corpuscles were seen as if they had undergone subdivi-

sions. Similar preparations made before the ascent showed no such appearances. M. Gaule therefore considers that at high altitudes there is an actual formation of red corpuscles and that this takes place with great rapidity. At the following meeting M. Tissot and M. Haillon gave an account of researches on a somewhat analogous subject. On November 21 they undertook some researches at various altitudes into the physics and chemistry of the respiration. Experiments were made at the following heights: 1,350 meters, 2,600 meters, and 4,450 meters in the case of M. Tissot, and at 1,700 meters and 3,500 meters in the case of M. Haillon. The chemical phenomena of the respiration did not vary appreciably at these different altitudes. The respiratory rhythm, however, was greatly modified. Although the total quantity of air entering the lungs was less the number of respirations was not sensibly altered. It would thus appear that at high altitudes the air is purer and more completely used.

THE London *Times* states that Sir Colin Scott Moncrieff, has been appointed by the Secretary of State for India to preside over a commission to consider exhaustively the possibilities of further protection against famine by means of irrigation. His colleagues will be Mr. Ibbetson (recently appointed to fill a prospective vacancy in the Viceroy's council), Mr. Higham, of the Irrigation Department, and the Hon. Mr. Rajaratna Mudaliyar, of Madras. The Punjab, Sind and Rajputana are the parts of India to be first visited as being most susceptible to the advantages of irrigation. Other provinces will then be taken one after the other, Burma alone being left unvisited. In order that the commission may be assisted in its inquiries by local knowledge, each provincial administration has been asked to nominate an experienced revenue officer to be a member of the commission for the period that it remains in the province. The terms of reference to the commission show that the inquiry will be of a most exhaustive character. The Government resolution points out that the irrigation works hitherto constructed by the State have on the whole proved directly remunerative, but it is recognized that the program of works of this kind may be approaching completion. The great storage works required for any considerable extension of irrigation in tracts most exposed to famine must necessarily be more costly per acre protected, and therefore less remunerative than completed works, which draw unfailing and perennial supplies from the great rivers of Northern and Southern India. As regards new works, therefore, the Commission is directed to regard as the main question not whether they will be likely to prove directly remunerative, but whether the net financial burden which they may impose on the State in the form of charges for interest and maintenance will be too high a price to pay for the protection against famine which they may be relied on to afford. One of the most valuable results that may be anticipated from the labors of a Commission taking this as its guiding principle will be to authoritatively set at rest the assumption that in all cases areas liable to famine can be protected by irrigation with comparatively small cost annually to the State.

THE London *Times* states that the National Association of British and Irish Millers have decided to institute an inquiry into the whole question of the relative strengths of English and American wheats, and have secured the cooperation of the Southeastern Agricultural College at Wye, Kent, in the agricultural side of the work. The question has arisen in consequence of complaints by agriculturists that English millers will not purchase English-grown wheats as they did formerly, but give the preference to American wheat, though they have to pay a higher price for it. The millers reply that, however favorably they may be situated for obtaining home-grown corn, they cannot sell for bread-making purposes flour made from English wheats, because they lack the strength of the American kinds. It is hoped that the inquiry will result in an improvement in the quality and yield of English wheat. For this season the Southeastern Agricultural College is sowing the same wheats on different soils; different manures are being tried, and the wheats in each case will be tested by milling and baking. New varieties are being obtained from Canada and

America, and selection and cross-breeding will be tried to improve the yield of the old varieties, not by increasing the size, but by increasing the number of grains in the ear.

UNIVERSITY AND EDUCATIONAL NEWS.

By the will of Mrs. S. C. Warren, about $150,000 is given for educational and charitable purposes, including $5,000 to Harvard University for the Peabody Museum of Archeology and $5,000 to Williams College.

Palmer College, at Le Grand, Iowa, has received $30,000 from Mr. F. A. Palmer, of New York, making $50,000 given to the institution in the last six months.

A cable despatch to the New York *Sun* announces that the Chinese government has decided to present to Columbia University a compilation of Chinese literature, history, maps, illustrations and official papers in acknowledgment of the establishment of a chair of Chinese history, language, customs and manners in that institution. The recommendation that such action be taken was made by Liu Kun Yi, the Viceroy of Nankin.

The Philadelphia correspondent of the New York *Evening Post* records the buildings to be erected at the University of Pennsylvania, as follows: Engineering building and machinery, $500,000; gymnasium building and ground, $400,000; medical laboratories, $500,000; veterinary building, $150,000; and various sums for additions to the chemistry and physics laboratories. About one-half of this sum has been secured, and the plans for the new engineering building have already been completed. The equipment will cost over $200,000, and the building $300,000. The site for the new medical laboratories has been cleared and work begun on the foundations. The trustees plan to have the laboratories ready for use by the opening of the next college year.

Mrs. George Holt and Miss Holt have endowed a fellowship in physics in University College, Liverpool, to be associated with the name of Dr. Oliver Lodge, formerly professor of physics at the College, and now principal of Birmingham University. Its annual value will be £100 or more. A prize to be called the 'Oliver Lodge Prize' has also been established by Dr. Lodge's friends and late colleagues, to be awarded annually to the best student in physics in the third year of the honors course.

Cornell University will hereafter confer the degree of 'Forest Engineer,' in place of 'Bachelor of the Science of Forestry.' The arguments presented in favor of this change are as follows: (1) The degree 'Forest Engineer' expresses more adequately than the academic degree now conferred, and according to precedent in other technical arts, the fact that not a science, but an art of technical character has been studied to a certain degree, namely the degree of entering the student into the profession. (2) It expresses the kind of work—namely, the application of technical scientific knowledge to a business end in a productive industry—for which the student has been prepared as a professional man. (3) It does not, as does the academic degree B. S. F., place the scientific basis and the literary accomplishment before the professional result. (4) It is, in the eyes of the world, a prima facie title of practical attainments, fitting for employment in practical rather than literary or scientific work. (5) There is sufficient precedent, not only in other technical arts for the form of title, but in the art of forestry, wherever a title has been given outside of this country, it has assumed the form of Engineer.

At its next session the Legislature of Pennsylvania will be asked to establish a School of Forestry.

Professor Luther Foster has resigned his position of vice-director of the experiment station and professor of agriculture in connection with the University of Wyoming at Laramie, in order to accept the presidency of the New Mexico College of Agriculture and Mechanic Arts located at Mesilla Park, and the directorship of the agricultural experiment station at the same place. Professor Foster was elected to his new position unanimously by the board of regents of the college and station on November 22, and assumed charge of the duties of the position on December 1.